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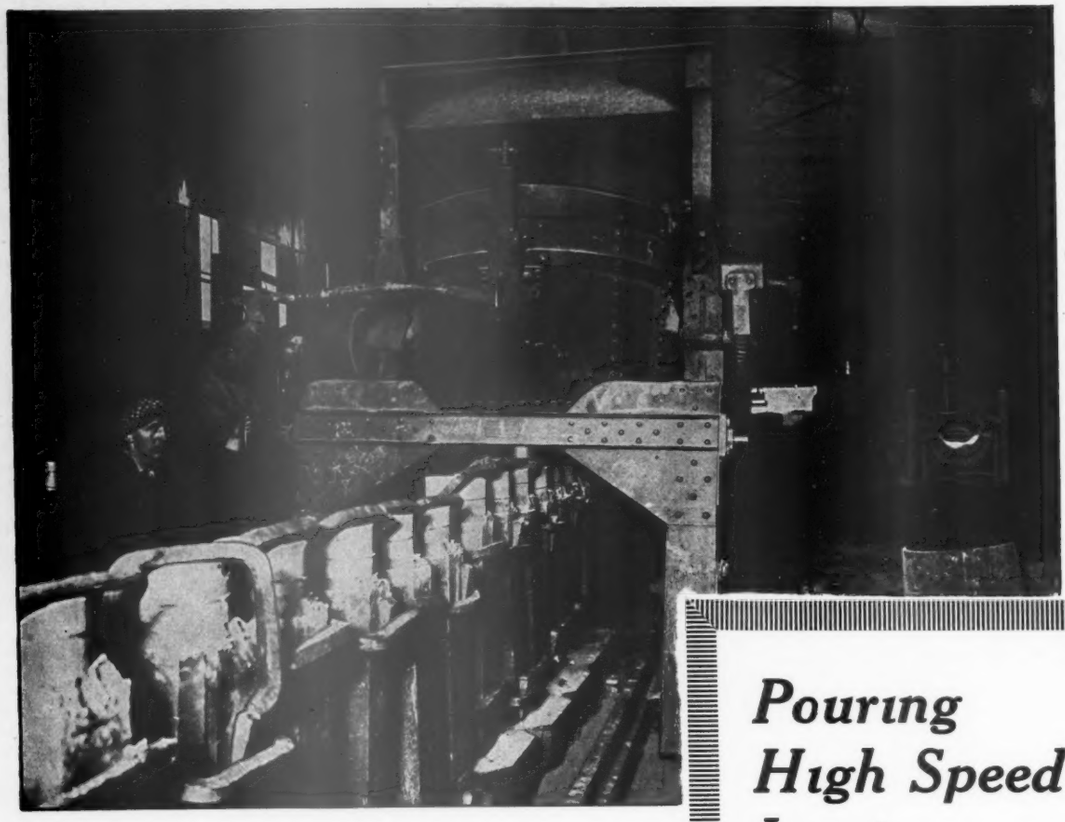

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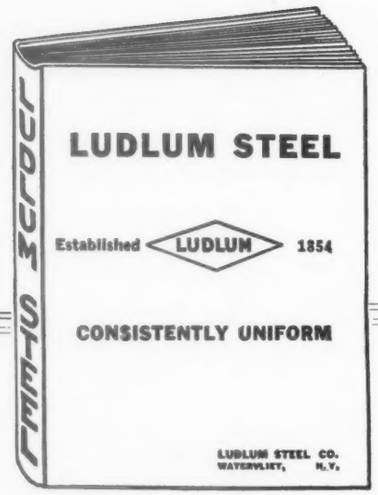

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Lubrication of Cylinders

Among the defects which, like hot boxes, seem to recur at more or less regular intervals, one of the most troublesome is repeated failures of cylinder packing. When such an epidemic occurs the blame is usually placed on the material from which the rings are made, the lubricating oil, or the condition of the feedwater, but very often it is necessary to make some changes in the design of the locomotive before the trouble is overcome. It is generally admitted that more difficulty is experienced in lubricating the cylinders of superheated locomotives, yet the quality of the oil apparently is not as important as the method of operating the engine. By keeping air and front end gases out of the cylinders, oil with a low flash point can be used with good success. Vacuum relief valves have not met with favor on superheated locomotives and many roads consider even by-pass valves unnecessary.

The manner of application of the lubricant is a matter on which there is considerable difference of opinion. On some roads the oil is fed to the valves only; on other roads pipes are run to both the valves and the cylinders, while some lubricate the cylinders only. It is worthy of note that some remarkably good cylinder packing mileage records have been made on roads that have adopted the practice of lubricating only the cylinders. It is found that the exhaust steam carries enough oil to the valve cages to lubricate them properly and the small supply thus secured prevents heavy deposits of carbon around the rings. There is also a growing tendency to dispense with swabs on the piston rods. If the cylinder is properly lubricated the rod itself will carry enough oil to lubricate the rod packing. One road that had adopted cylinder lubrication without swabs averaged 65,000 miles per set of piston rod packing on superheated locomotives.

The higher cylinder temperatures obtaining with superheated steam have brought about marked changes in the design of piston packing rings. Wide rings have been found unsuited for this class of service and many roads have secured excellent service from rings having a width of ⅜ in. Gray iron does not possess sufficient strength for such narrow rings and special hard cast iron must be used. With the possibility of further increases in steam temperatures it may be necessary to make other modifications in the arrangement of the cylinders. The bronze faced piston offers another expedient for overcoming difficulties met in lubricating cylinders, but the fact that hard cast iron bull rings and cylinder bushings have been used successfully at extremely high temperatures indicates that it will hardly be necessary to have recourse to such construction.

The Possibilities of Electric Steel

The past decade has witnessed the substitution of steel castings for forgings in many locomotive and car parts. However, forgings are still used to a considerable extent for parts which are of such shape that they cannot readily be made on a forging machine or power hammer and could be made more cheaply if cast. While the field for ordinary steel castings has no doubt been practically exhausted, the possibility for wider application of electric steel castings in place of difficult forgings deserves thorough consideration. The casting of steel by the electric furnace process allows of more accurate control of the chemical composition and gives the product a higher tensile strength than can be secured by the open hearth process. While the cost is higher than that of ordinary steel castings, it would not be as great as the expense of making even a fairly simple forging.

By making some parts that are difficult to forge, such as safety chains for locomotives and cars, of electric steel, a marked saving should result and the strength might also be

considerably increased. For example, the specifications for electric cast steel chain specify an ultimate strength more than 40 per cent higher than for the corresponding size of welded iron or steel chain. Aside from the substitution of electric steel castings for forgings there should be a wide field for the use of this material in parts that are subject to failure. Often some cast parts of locomotives or cars do not possess sufficient strength and cannot readily be redesigned. The use of electric steel should overcome the difficulty, because it reduces the failures in sections that are difficult to cast and gives the parts both higher elastic limit and greater ultimate strength.

Helping the Valve Setter

Not infrequently a valve setter will connect up the motion work of a locomotive and roll the wheels, only to discover that the valve chamber bushings are a little too near together or perhaps too far apart. This necessitates removing the main valve to adjust or renew the bushings, resulting in a delay in turning the locomotive out of the shop which could have been avoided by careful inspection when the main valves were first removed. The distance from the link trunnion center to the steam edge of the back port of a locomotive with a Walschaert valve gear is very important; at least it should be the same on both sides, or the valve settter will be obliged to make corresponding alterations in the right and left valve stem lengths. If the check is made soon after removing the motion work from a locomotive there is ample time to make necessary alterations without delaying the valve setter later on. The article referred to on page 166 describes a gage for measuring this distance and also indicates a method of handling motion work and valve gear parts through the repair shop that has speeded up the work and made possible not only a greater output but a better operating valve gear.

Expressed in its simplest terms, the idea has been to get busy with the repair work just as soon as the locomotive was stripped, carefully checking all fundamental valve gear dimensions, making all valve gear parts correspond with the blue print, and getting those parts back to the erecting shop promptly. With this method locomotives are not delayed by mistakes found at the last minute. The valve gear parts, being all standard, go together quickly and easily. No extensive alterations are needed and the work of the valve setter is greatly facilitated.

Locomotive Frame Jaws

With the increased weight of locomotives it has been necessary to provide heavier driving boxes and much larger bearing surfaces between the driving box shoes and wedges and the frame jaws. It is not uncommon today to find frame jaws 6 or 6½ in. wide and 26 in. long. These jaws must be maintained both square and true. Every time the driving wheels revolve a pressure of 80,000 lb., or even more, is transmitted through the rods and wheels to the frame jaws. A variation of 1/64 in. is often sufficient to cause shoe breakage. Any one who has ever taken a file and attempted to straighten one of these large frame jaws will admit that it is both a long and tiresome job. The frames are composed of tough steel, which it is almost impossible to remove in any considerable amount with a file, and if the frame is worn out of true as much as 1/16 in., it is necessary to use a hammer and chisel to chip the bearing. This again is a time consuming operation.

It is absolutely essential that frame jaws should be maintained straight and it seems probable that a considerable saving could be effected by the use of a portable milling machine or grinder to do the work. Several successful portable machines of this type have been devised but have not been adopted to any considerable extent up to the present time. While the portable milling machines are reported to have given good satisfaction, it seems probable that the best results could be obtained by the use of a grinding machine. After a locomotive has been in service for eight or ten months without having its shoes and wedges renewed, a careful inspection of the frame jaws will usually show that they are worn slightly out of true and the bearing surface is hardened and glazed. In fact, the bearing surface of the frame jaw has the appearance of being almost casehardened. The hardened surface is very difficult to remove with a file and a milling cutter would have to take a cut sufficiently deep to get under it. This difficulty would be obviated by the use of a suitable grinding machine. Such machines have been developed and it is probable that they will be extensively used in the future.

College Men and Railroad Work

There has been much criticism of the shopmen's wage schedule, which was made effective by the Railroad Administration, because it does not provide for continuing special apprenticeship courses for college graduates in railroad shops. Some of the university authorities have even gone so far as to protest against this to the mechanical department of the Railroad Administration. One of our correspondents took up the cudgels in favor of the college man in a letter which was published in the *Railway Mechanical Engineer* of January, 1920, page 4.

Why should the college graduate be granted special favors? It is true that the railroads need him—and need him badly—but why discourage those who have not had this special training by practically serving notice on them that the college man, by being given special training, will be rushed into the more desirable official positions? On another page we publish data as to the number of apprentices in each craft on all of the roads under federal control. If the railroads will awaken to their full responsibility (and they have fallen far short of it) in the matter of recruiting and training their employees, the question of the college man in railroad service will automatically solve itself. Would it not be far better, for instance, to give those of the regular apprentices who show marked ability along certain lines an opportunity to take up a technical course or of adding to their technical knowledge beyond that which is taught in the ordinary apprentice courses on a road which has a modern up-to-date course of training? George M. Basford as far back as 1905 made the statement that "the special training of young men from without the ranks of the workers, for official positions, is fundamentally wrong, and furthermore it plays strongly into the hands of those who wish to see men levelled into classes and considered as on uniform levels as to the value of service." The railroads need technically trained men—lots of them—but why not go at the task of recruiting them in an intelligent, orderly and logical fashion?

Railroads will continue to take college men into their organizations from outside; but these men need not be given special privileges. Let them come into the organization on their ability and merits, and let them demonstrate their fitness for official positions in competition with others who may have less technical training. Do not further handicap the ambitious young man in the ranks, but rather get behind him and help him to overcome the handicap he already carries. Do not lose sight also of the fact that the successful executive must understand and appreciate the importance of the human factor; the man developed from inside the organization who has had to rub shoulders with the workmen in the formative period of his life may have advantages in understanding his

fellows, which if properly appreciated will give him a big advantage, if his technical training is continued, over the college man who comes into the organization for the first time after he has completed his technical training.

It may not be amiss in this connection to quote the following paragraph which is part of the conclusion of Mr. Basford's address to the 1905 convention of the Master Mechanics' Association: "For the men and officials of the future, technical education is required, but it must be obtained while the student otherwise prepares himself for his work. It must go hand in hand with his education in the service, and the education must be arranged especially to suit his needs. For the engineering education he must not be required to fit himself to existing schools. A new school must be developed specially for him. Instead of giving years to subjects which are merely good for mental training, he must give months to those which he will remember. Moreover, he must not separate himself from active work and responsibility for long periods in order to attend school."

Compulsory Metric Legislation

Elsewhere in this issue there is published a communication which calls attention to pending legislation making the use of the metric system compulsory. The author of the letter sums up the objections to the introduction of this system from the standpoint of the mechanical department and his arguments against its adoption should be carefully considered, as the issue is one which must be met squarely when the bill is introduced before Congress. Similar proposals for requiring the use of the metric system have been made before and have been rejected. Nevertheless, it is a mistake to assume that this measure will fail and that active opposition is not necessary. The present agitation for the metric system is due to the organized propaganda for the World Trade Club. It is sponsered by an individual who has made the metric system his hobby and has furnished large amounts of money to carry on the campaign, which has been so conducted as to make it appear that there is an overwhelming sentiment in this country for the adoption of the metric units. Unless industry in general makes known its opposition to the proposed legislation, there is danger that an active minority will be able to secure the enactment of legislation that will be burdensome and detrimental to the business of this country.

The metric system has had every opportunity to displace the present system in the United States. If its merits were as great as the advocates of this system claim, compulsory legislation should not be necessary to secure its adoption. Metric weights and measures have been used in France since 1793, and although penalties have been imposed for the use of the system formerly in vogue, the old units are in use even today in some of the French industries. The metric system has been legal in the United States for many years, but the advantages which it possesses have not proved sufficient to lead to the displacement of the English units. One prominent company which adopted the metric system when the business was founded abandoned it after 30 years. Other industries have had similar experiences, and at the present time the metric system is used in this country only in scientific work.

The metric system has been in use for a sufficient length of time to demonstrate whatever merits it possesses. The experience of other countries which have made the use of metric units compulsory proves that the old units never entirely disappear, but the metric units are added to those already existing, creating additional complication instead of the simplicity which is claimed for the system. Railroad men should realize the danger of compulsory metric legislation and should not allow laws which would affect them so directly to be passed without having their protest heard.

COMMUNICATIONS

I. A. OBSERVES ROUNDHOUSE OPERATION

WASHINGTON, D. C.

DEAR EDITOR:

While Imperial Government are operate RR, I. C. C. detectors no longer can issue Form 5 invitation on hon. MM, so U.S.R.A. employ Jap detector as Shop detector. It our august duty to learn why former proud haughty RR and MM find impossible to keep running U.S.R.A. std. locomotive and car.

In pursuit of duty, Hon. Boss Detector send for me pos haste. I execute double quick to headquarters and learn Hon. Boss much exercised for Green River Jct.

RR building new roundhouse there, which are not perform right. Jap detector empowered to find what are wrong without delay.

Arrive Green River Jct. Find engines standing emitting steam to atmosphere, which are very cold and result in condensed steam return to earth like snow. Detect further find loco. house situate on bank of river which looks fine, but it are situate so close to bank, that outside wall turn table pit are in river. This account for phenomena observed when RH are approached. Juice have fail on motor, which make it nice to push 90-feet table by hand when river are on one side.

Roundhouse look out west, so when doors open let engine out, let wind in, which result in economy; as do without sweeper.

Find machines all motor push, which are good. However, main transmitter are blow out on occasion visit; no table, no machines, no pump, no water for boiler—whole damn works go to hell fast. But RR demand engines. RH foreman tells them, "engines here, he are impotent, come get 'em."

Detect no sand; reason it are froze. RR order when hot climate, get it when begin to be cold. No men to unload, stand, freeze tight, no sand. Picks, dynamite, sand stick by car like rock of gibralter. Build fire in car, thaw some, but only one sand-stove to dry sand. RH foreman, swear, say, "take sand to stick by job."

Report back Hon. Boss, Green River Jct. all right, if build right. Advise he send chief shop line-drawer to operate.

INO AMSURA.

EXHAUST NOZZLE AREAS

CHICAGO, ILL.

TO THE EDITOR:

In designing the essential features of a locomotive on the horsepower basis, the boiler pressure and the diameter of the cylinders can be inversely varied without affecting the result. To illustrate the point, the diagram herewith shows two locomotives having the same boiler, but by reason of using different pressures the cylinders have different diameters. The tractive effort, speed and power remain unaffected —the two machines are equal.

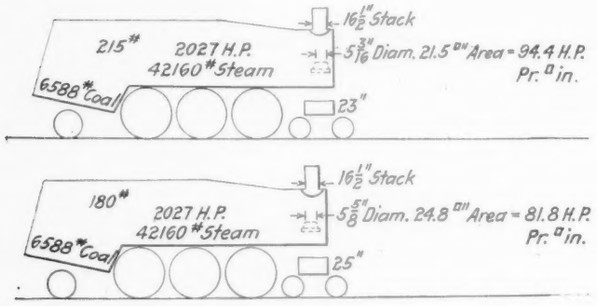
The amount of fuel burned and the water evaporated produce a constant volume of products for ejection through the stack, which of course remains unaltered, being designed on the basis of horsepower.

The function of the exhaust jet is to eject through this fixed size of stack a definite bulk and pressure of used material. A logical step is to make the exhaust nozzle size constant. In its course from the boiler to the nozzle tip the steam has been subject to equal losses from expansion, cool-

ing, etc. If it flows out at a constant pressure it performs a constant amount of work in clearing the smoke box, producing combustion. This would normally produce different back pressures in the cylinders, the higher in the smaller cylinder and a lower pressure as the diameter of the cylinder increases.

If now having laid down the prime idea, we admit that modifications should be, or would be introduced in practice, we still have little reason to believe that such a difference as exists under the present method (shown on the sketch—5 3/16 and 5⅝ in. diameter) would be required to accommodate them.

This is not a proposition to increase nozzle sizes. It



It would rather seem wise to accept the average of the present practice calculated on this new basis as the foundation. The very considerable increase in size found practicable in tests not long since is consistent with this method. Just as reasonably would a reduction in size for other locomotives follow and benefit be expected. Averaging present practice would have:

61 hp. per square inch nozzle area for 1,200-hp. boiler.
69¼ hp. per square inch nozzle area for 2,000-hp. boiler.
76⅓ hp. per square inch nozzle area for 2,800-hp. boiler.
79¼ hp. per square inch nozzle area for 3,200-hp. boiler.

Thus a starting point could be established. So far as is known no practical systematic test of this plan has been made, but this idea is presented in the belief that it has legitimate interest for builders and users of locomotives.

S. C. Frank.

COMPULSORY METRIC LEGISLATION

San Francisco, Cal.

To the Editor:

Do the readers of your magazine fully realize the effort being made both in this country and in England to make the use of the metric system (the gram-meter-liter system) of weights and measures compulsory? A live, active organization is behind the movement, and so effectively has it worked that legislation is already pending both in our own National Congress and in the British Parliament which, if enacted into law, will not only make the decimal or metric system standard but will prohibit the use of our present system. From organized headquarters circulars are being sent out by the advocates of this legislation, urging the recipients of this literature to immediately write their Congressmen, the Bureau of Standards, Department of Commerce, President Wilson, Lloyd George and the British Parliament endorsing the proposed legislation, in order (so they claim) "that America and the English-speaking people in general may keep pace with the rest of the world" and our industrial development be no longer hindered by what they term "an antiquated jumble of weights and measures deliberately fastened upon us by Germany." So active have the champions of the metric system been that unless the opponents of the proposed change awaken to the seriousness of the situation there is great danger of this legislation being passed before those most vitally concerned really know what is going on.

It is not the purpose of this letter to discuss the merits of either system. We are willing to admit even that were we back to the days of creation or even to the beginning of our present industrial development we might favor the decimal system as being slightly superior to the system now in use. But the question of changing at this stage of the game to *any* system, no matter how superior it might be, is a very different proposition and involves such serious consequences that we believe it merits most careful consideration.

It is easy enough for a handful of college professors, or a World Trade Club with no financial interests involved, or possibly with an axe to grind, to advocate the adoption of a world standard system of weights and measures and to try to prevent the use of the system now in use; but before deciding to follow their advice it is well to consider the disastrous effects that would follow any attempt to change from one system to another.

Industry would be demoralized. Every machine for making a bolt or nut. a tap or a die would have to be redesigned. Likewise the machines used in the making of other machines. Every specification for a locomotive or car, an automobile or power plant must be changed. Boilers and cylinders must be redesigned. Pressures in pounds per square inch must be converted to grams per square centimeter. In fact, every device entering into the construction or repair of anything of a mechanical nature must be redesigned to conform to the new standard. It is difficult to conceive which would cause the worst jumble, to make the change instantly or gradually, but it would be a physical impossibility to make such a change instantly. If the change were made gradually, during the period of transition we would be confronted with the encumbrance of two sets of standards, some parts being made by one and possibly its corresponding part by the other system. The theorist may tell you that the actual sizes need not be changed but only the terms used to designate the dimensions, but any mechanic knows the serious consequences that would arise from trying to fit one part designed by one system with another designed according to a different system, having no exact equivalent to any unit in the first system.

Moreover, every drawing, or tracing, ar blue print would have to be changed and most of them scrapped. Do you realize how serious this phase alone would be? Text books and reference books and file copies of many magazine articles would become obsolete. What a jumbled mess it would all be!

Workmen would have to be re-educated. Through years of training and experience they have become accustomed to our present system. To discard this and replace it with any other system, even though slightly superior, would greatly impair the efficiency of our shop forces for at least a generation to come. The mechanic must not only be able to use the standard system of measurements, but must be able to *think in* terms of them; otherwise we cannot expect him to greatly further the progress of industrial development.

Surely no arbitrary legislation should be enacted without the full knowledge and consent of those most vitally concerned in our industrial welfare. It is easier to scramble the eggs than to unscramble them, as politicians and railroad men have found out. We are living in an industrial age—an age wherein greater achievements have been made than in all the preceding days of history. But we are just at the beginning. Surely we should not swap horses in midstream, unless this is found to be absolutely necessary. What group of men are more vitally interested or more competent to pass on this question than your readers? What do you think about the proposition?

A Conservative.

ADVANTAGES OF STOKER FIRED LOCOMOTIVES*

Stokers a Necessity on Large Modern Power Slack Coal or Screenings Not Economical Fuel

BY D. F. CRAWFORD
Vice-President, Locomotive Stoker Company

AS there are approximately 5,000 mechanically fired locomotives in the United States, it will be of interest to consider three questions: First, what led to the introduction and continued application of locomotive stokers? Second, what has the experience gained during their development and use indicated? Third, what are the questions brought about by their introduction, which must be considered by the railway officers?

My statement to the convention of the Master Mechanics Association in 1913 contains an answer to the first question. "The development of the locomotive stoker on the Pennsylvania Lines was brought about by a desire to get more tons per train over the road. I had observed in the annual reports of many of the railroads, the tons of train hauled per pound of tractive power was decreasing as the engines grew large. I found that locomotives that were 20 per cent larger than other locomotives were hauling the same trains as the smaller ones and were not realizing the full 20 per cent additional tractive power that the locomotives had. The stoker problem to me was one of decreasing operating expenses by increasing the train load for each unit on which we had to pay interest and maintenance charges."

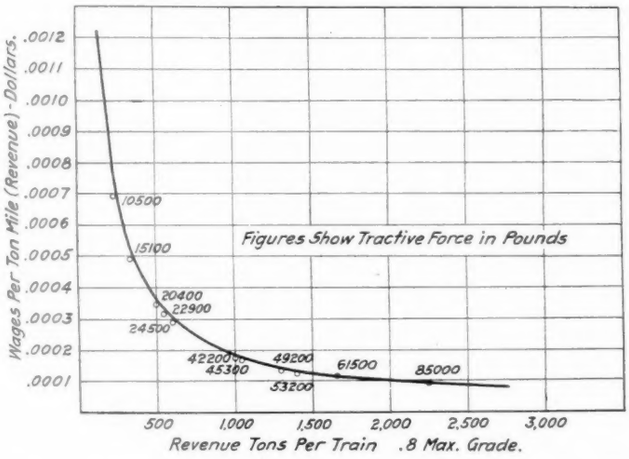


Fig. 1. Relation of Tractive Effort and Tons per Train to Wages per Ton Mile (1914 Rates Applied to Various Classes of Locomotives).

C. D. Young, after consideration of certain locomotive tests, stated: "If we use 6,000 lb. of coal, and this locomotive is capable of burning 10,000 lb. per hour, or say, if a fireman will fire 6,000 lb. per hour, and the locomotive is capable of burning 10,000 lb. with a stoker, it is then possible for you to obtain the maximum of that locomotive with the stoker, whereas you do not come to 60 per cent of the maximum output with the fireman."

These statements made in 1913 are of equal value and importance in 1919, and after all are the fundamental reasons for the existence of the locomotive stoker. While what we regard as large locomotives were in limited use before the advent of the stoker, its development and application has and will permit more full utilization of the capital invested both in the locomotive and in the permanent way through increases in tonnage and speed.

*From a paper presented before the Railway Club of Pittsburgh.

Stokers Reduce Transportation Costs

The expense of moving freight does not increase in proportion to the weight of the train, and therefore the larger the train the lower the cost per ton mile. Among the items which may be considered as decreasing in cost per ton mile in some proportion to the increase in tons per train are fuel costs, (which amount to 9.85 per cent of the total expenses) crew's wages, equipment, track structure and signal maintenance, as well as certain other fixed and operating charges.

The effect of the introduction of large locomotives on a given division operated to their capacity (which the mechanical stoker makes possible) is shown by the curve in Fig. 1, in which the crew's wages per ton mile are shown in comparison with the revenue tons per train. This indicates the results that may be expected by the use of locomotives of various capacities.

That there is a definite relation between the coal used per ton mile and the revenue tons per train, is clearly shown by the diagram in Fig. 2, which shows the coal used per ton mile for the various weights of train for nineteen railroads in various parts of the United States, this information being obtained from the annual reports of the railroads included. Notwithstanding the wide variation in traffic, operating, grade and equipment conditions and the quality of the fuels used, the fact that increased train loading brings a decrease in fuel per ton mile is substantiated.

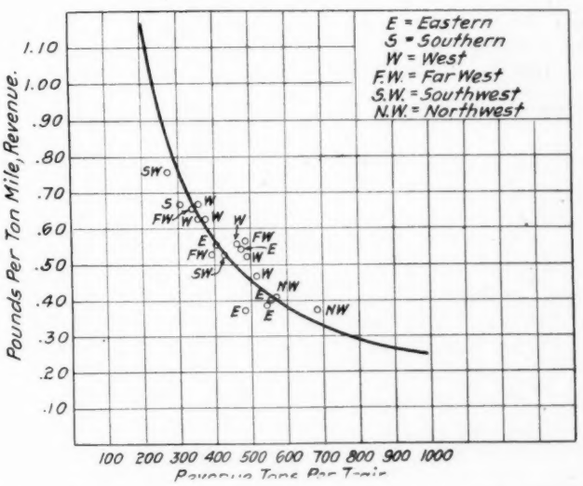


Fig. 2. Relation Between Tons per Train and Coal per Ton Mile on Typical Roads

It is of course difficult to state in a few words just what the use of locomotives of large capacity has meant to those making use of the transportation facilities of the country, but, by their use the average revenue tons per train in the United States was increased from 176 tons in 1888 to 357 tons in 1907, and 620 tons in 1917.

This increase in the amount of traffic moved by a train unit permitted the results disclosed below:

Year	Revenue tons per train	Receipts per ton mile	Receipts per train mile	Cost of fuel per train mile	Cost of Fuel per Ton Mile: Actual price	Cost of Fuel per Ton Mile: Equated price	Price of coal per ton
1888.....	176	$0.01001	$1.76	....	.....	.....	....*
1907.....	357	0.00759	2.71	$0.21	$0.0006	$0.0006	$1.14
1917.....	620	0.00728	4.51	0.43	0.0007	0.0004	2.20†

*Information not available.
†Estimated from the price of coal in various districts as set by the Fuel Administration and is a conservative figure for the average cost to the railways.

Notwithstanding the fact that in 1917 the price of coal is shown as nearly double that in 1907, the cost of coal per ton mile was practically the same, and when the price is equated to that of 1907, the decreased cost per ton mile given shows conclusively that a smaller amount was used.

Heavy Train Loading Increases Track Capacity

Another important reason for the use of locomotives of the capacity made available by mechanical firing is the reduction of the number of units or trains required to handle a given traffic.

About five years ago query was made as to what would have been the effect if the traffic of a given railway system in the year 1912 had been moved in equipment of the capacity that had been used in 1903. Of course, in making the calculations for the reply, some factors had to be assumed; the conclusions at least indicate the propriety of the increase in capacity of both locomotives and cars.

While a larger number of the smaller locomotives and cars would be required, the fact that the number of units or trains needed so increased the traffic density that, to make the movement with the same degree of promptness as existed in the latter year, the cost of providing additional track facilities far outweighed the cost of the additional equipment. As it is only by the use of a mechanical stoker that the posssibilities of large locomotives may be realized, the information given above becomes the reason not only for their development but for their more general application.

Stokers Eliminate Necessity for Two Firemen on Large Engines

In 1903, with locomotives of about 40,000 lb. tractive force and 50 sq. ft. of grate area, from time to time complaints were received from the firemen regarding their arduous work, and frequently men left the railroad service, preferring to seek a more congenial occupation. This, of course, embarrassed the service, as at times it was difficult to obtain sufficient men to supply the demands, and I well remember the concern of those responsible on account of the large turn over and its effect on the operations. As the size of the locomotives continued to increase, the difficulties and complaints grew apace, and it may be said that the climax occurred in 1912, when the firemen in the Eastern Wage Application demanded two firemen on locomotives weighing over 200,000 lb. on the driving wheels.

During the period mentioned, several types of mechanical stokers had been built and put in service, but were regarded by both the railway officers and employees as rather more than less in the experimental stage. Nevertheless such was the confidence of some railway officers in the stoker that what may be regarded as the first commercial application of the device was made in 1910. Since that time the number applied per year has gradually increased to the total of 5,000 in use on the locomotives of at least 71 of the railroads of the United States.

Assuming that 120 lb. of coal per sq. ft. of grate per hour is required to obtain the capacity of the locomotives, the average coal rate for typical stoker-fired engines would be as follows:

Mikado	Grate 70.5 sq. ft.	Coal per hour 8,460 lb.
Santa Fe	Grate 83.0 sq. ft.	Coal per hour 9,960 lb.
Mallets	Grate 89.2 sq. ft.	Coal per hour 10,704 lb.

Evidently some locomotives of these dimensions are worked below the capacity suggested by the builders' formula of 120 lb. of coal per square foot of grate area per hour, or certainly there would be more stokers in use.

Even if half the amounts of coal per hour given above were to be fired by hand for any considerable length of time, it is probable that the limit of endurance of the men, especially during the warm seasons, would be approached and therefore the stoker will afford the required relief and will be accepted as a substitute for the second fireman so frequently requested. In fact, I am inclined to believe that in time the stoker will be preferred, as by the use of the stoker the period elapsing from employment to promotion to engineman will not be increased, which would be the case were a second fireman employed on all locomotives.

Fuel Economy and Stoker Firing

As it is evident that only the furnace efficiency is affected, whether a boiler is fired manually or mechanically, many of the tests of stoker-fired locomotives which have been made, must be disregarded, as the results obtained clearly indicate failure to differentiate between furnace, boiler and engine efficiency.

Indeed, I can only conceive of one reason why under equivalent draft, structural and adjustment conditions a manually fired furnace should show a better performance than a mechanically fired furnace. That is, that firemen might be able to more accurately distribute the fuel, supplying the fresh coal exactly to the points on the grate required, as indicated by the color of the fire, and I can only think of one reason why the mechanically fired furnace should give the better results, namely, it is unnecessary to so frequently open and close the furnace door, permitting a more uniform fire-box temperature to be maintained.

It is probable that in locomotive practice each of these theoretical advantages offsets the other, especially at combustion rates approaching the limits of manual firing, beyond which the mechanical device is superior, due to the fact that accurate distribution can no longer be made.

The equivalent evaporation per pound of coal depends on the amount of coal burned per square foot of grate per hour rather than whether the furnace is fed manually or by a mechanical device. As the stoker is applied for the sole purpose of amplifying the output of the locomotive by causing more coal to give up the power contained therein, it follows that the evaporation rate will decrease in proportion to the combustion rate obtained.

The coal consumed per gross ton mile cannot be considered an accurate measure of the difference between mechanical and manual firing, as not only are the efficiencies of the boiler and engine variable factors, but the resistance of the train as determined by the number and weight of the cars must be given consideration.

The unit ton miles, while sufficient for rough comparisons, should not be depended upon when definite information is required.

Although it is true that the pounds of coal per indicator horsepower hour, also involves the performance of the cylinders, by careful selection of the locomotives, as to similarity in engine conditions, this unit may be regarded as fairly valuable in making comparisons.

The diagram in Fig. 3 shows the results of some tests where the information obtained is compared on the last mentioned basis. It will be moted that for the higher rates of combustion, and consequently lower boiler efficiency, the curves indicate that the coal consumption per indicated horse-

power hour favors the stoker-fired locomotive, also that when superheated steam is used there is a marked difference in favor of the mechanically fired locomotive. In the latter case, however, the excellent results shown were obtained by increasing the diameter of the cylinder equal to about 10 per cent, as it was found that with the stoker this could be done on account of the ample steam supply. Indeed further experiments justified further increasing the diameter of the cylinders equal to about 17 per cent, with a proportionate gain in hauling capacity.

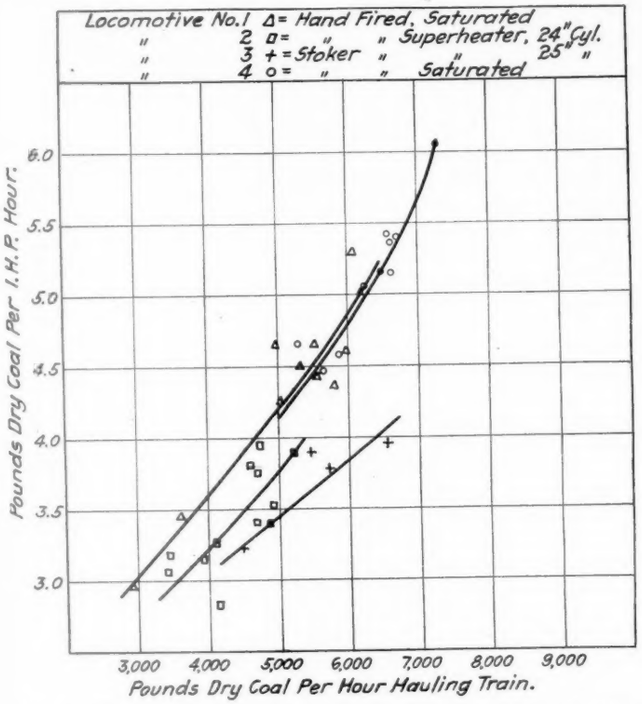


Fig. 3. Comparison of Coal Used per Indicated Horsepower Hour with Hand and Stoker Firing

A possible increase of 17 per cent in the earnings per train mile is surely sufficient to be attractive to those responsible for the financial results of railway operations and to justify the application of a device which permits such conditions.

Fuel Economy Depends on the Fireman

How many of us have taken the trouble to ascertain the effect in coal consumption of inexperienced firemen?

The tabulation gives the results obtained on some tests made to develop the facts. It will be observed that the difference when the locomotive is doing the same work is 22 per cent.

Did it ever occur to you that there are really very few experienced stoker firemen? Why should you expect the same results from inexperienced stoker firemen that you obtain from experienced hand firemen? When tests with firemen of equal skill handling the stoker and the shovel show that more coal is being used on the mechanically fired locomotives, you may rest assured that you are getting a return for it either in increased tonnage or increased speed.

Steam Jets Increase Boiler Efficiency

Four of the six types of stokers for locomotives now in service use steam jets to project the coal into the fire-box. It has been stated that the introduction of steam into the fire-box for this purpose results in decreased evaporative efficiency. Just what has led to these statements, I am at a loss to understand, as very early in my railroad experience I was informed as to the desirability of wetting the coal to improve the combustion, and we are all familiar with the wide use of steam jets in stationary boilers, especially those equipped with certain types of mechanical stokers.

In 1912 and 1913 tests were made under the direction of the General Managers Association of Chicago to determine the effect of steam jets on the amount of smoke emitted from a locomotive, and of course one of the factors was the effect on fuel economy.

From the results of these tests published in the American Railway Master Mechanics Association, the data shown in the tabulation was obtained. The data is supplemented by

EFFECT OF STEAM JETS ON EVAPORATION

WITHOUT BRICK ARCH.

Test No.	Coal fired per hour: Total	Coal fired per hour: Sq. ft. grate	Steam through jets, lb.: Per minute	Steam through jets, lb.: Per hour	Equiv. evap. lb.	Per cent lb. steam to lb. coal
79	2,025	69.5	7.56	453.6	8.7	22.3
80	1,786	61.3	12.97	778.2	9.8	43.5
81	827	62.7	0	0	9.3	0.0
82	1,961	67.3	13.78	826.8	8.9	42.0
83	1,961	67.3	17.64	1,058.4	9.1	54.0

WITH BRICK ARCH

Test No.	Coal fired per hour: Total	Coal fired per hour: Sq. ft. grate	Steam through jets, lb.: Per minute	Steam through jets, lb.: Per hour	Equiv. evap. lb.	Per cent lb. steam to lb. coal
84	1,820	62.4	17.64	1,058.4	9.7	58.5
85	1,692	58.0	7.56	453.6	10.4	26.6
86	1,811	62.1	0	0	9.5	0.0
87	1,784	61.2	13.78	826.8	9.5	46.2

Speed—12 M. P. H.—Full throttle—25 per cent cut-off.

RESULTS OBTAINED WITH EXPERIENCED AND INEXFERIENCED FIREMEN (HAND-FIRING)

Trials of Coal—Chicago District

All Tests at 80 r. p. m.,—14.66 m. p. h.—**25 per cent cut-off. Length of each test, two hours**

Coal	Average boiler pressure: Ex.	Average boiler pressure: Inex.	Total coal: Ex.	Total coal: Inex.	Total water: Ex.	Total water: Inex.	Steam lost at safety valve: Ex.	Steam lost at safety valve: Inex.	Average smoke per cent: Ex.	Average smoke per cent: Inex.	Brick arch
Macoupin	199.5	198.7	6,528	7,737	19,145	38,571	0	144	30	42	None
Williamson	205.8	205.4	5,762	5,568	39,727	41,482	174	678	24	20	"
Williamson	204.5	204.8	5,970	6,284	42,874	43,457	504	2,992	14	16	Arch
Sangamon	205.1	142.6	5,897	*2,887	40,077	*16,436	0	0	18	52	"
Green	206.0	204.3	5,264	6,442	41,052	41,042	154	1,344	8	25	"
Vermillion, Ill.					40,557	44,519	304	4,504	22	34	"
Vigo	204.5	203.8	5,480	6,057	39,782	40,807	532	318	20	22	"
Vermillion, Ind.	205.4	203.2	5,445	6,676	40,874	42,534	78	288	16	28	"
Sullivan	203.2	203.2	5,557	8,192	39,514	42,734	0	2,338	28	52	"
Saline	206.0	204.3	4,908	7,263	40,232	42,826	556	3,132	24	64	"
Marion	205.0	184.1	6,146	7,832	40,005	35,393	240	652	14	30	"
Total	2,044.1	2,016.3	56,824	69,306	403,762	413,365	2,542	16,390	200	334	....
Average	204.4	201.6	5,682	6,931	40,376	41,337	254	1,639	20	33.4	....
Percent. excess	....	....	....	22.0	....	....	....	541.3	....	67.0	....

Ex.—Experienced fireman. Inex.—Inexperienced fireman. * One hour test.
In the total and averages, the figures for Sangamon coal have intentionally been omitted, as two inexperienced firemen failed to maintain the boiler pressure on a one-hour test.

the following statement: "The tabulated results of the efficiency tests with Pennsylvania Gas Coal (Tests Nos. 2500-79 to 2500-87) with and without the jets are plotted. The curves show that a reduction of smoke results in an increased equivalent evaporation, and a corresponding increase in efficiency and economy with or without the brick arch, showing that the steam jet tubes make for improved combustion and economy rather than simply to "whitewash the smoke."

With this evidence before us, I do not think for the present at least we need be concerned as to the deleterious effect of using steam jets for projecting the fuel into the firebox, for if the use of as much as 1,000 lb. of steam per hour with 2,000 lb. of coal per hour does not result in reduced economy, certainly the introduction of from 300 to 500 lb. of steam per hour into a fire of 5,000 to 7,000 lb. of coal per hour will not adversely affect either the evaporation or the annual balance sheet of the railways using this arrangement.

Slack Coal Not Economical

We all appreciate that one of the arguments for the introduction of the locomotive stoker was the possibility of using the less expensive grade of coal known as screenings or slack coal, and consequently a number of stokers especially adapted for its use were installed.

Of course it was expected that the decreased cost per ton would offset the increased consumption, but the practical difficulty not only of supplying the special coal, but the necessity of carrying two kinds of coal at coaling stations, one for hand and one for stoker-fired locomotives, indicated the advantage of a stoker so arranged that it would handle run of mine or even lumps by breaking it to a suitable size on the locomotive.

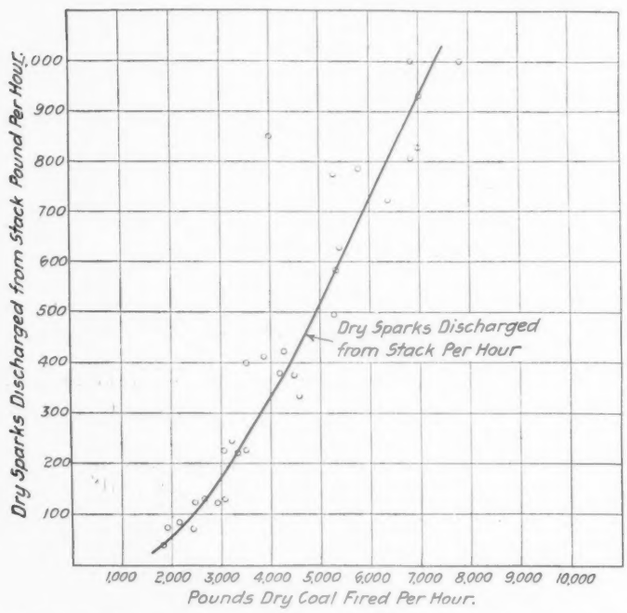


Fig. 4. Relation Between Rate of Firing and Stack Loss, Hand Firing

There is, however, a much more important reason for avoiding the use of screenings or coal of small size than the inconvenience of providing it prepared or crushing it at the coaling stations. That is, the question of quantity of fuel used.

Some comparative tests were recently made on stoker-fired locomotives. On one series of tests, coal which would pass through a two-inch screen was used, and the other series made with coal which would pass through a 6-inch, but over a 2-inch screen, in the latter case the larger lumps being reduced by the breaker in the stoker conveying mechanism. The advantage obtained in using the larger coal is apparent and amounted to over 15 per cent.

The principal cause, no doubt, of the decreased efficiency of the finer coal is the loss due to the unburned coal being thrown out of the stack. The amount of this loss of course depend upon the rate of firing and the relative fineness of the coal. The diagram in Fig. 4 shows only the relation between the stack losses and the rate of firing.

The stack losses, which run as high as 15 to 20 per cent of the coal fired, have no other relation to the method of firing except that it is the usual practice to fire at higher rates mechanically than manually.

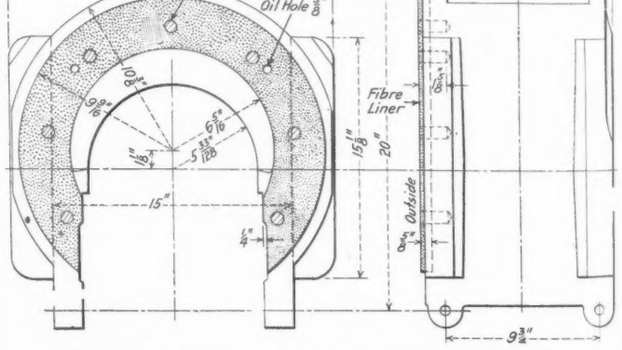
It should be borne in mind that the stoker is a mechanical device; that it will only do what a human being makes it do; that it cannot tolerate neglect. If it is properly inspected, lubricated, maintained and operated, it will add to the earnings of the railroads, the comfort of the employees and banish troubles due to engines not steaming.

DRIVING BOX LINER

BY A. G. JOHNSON
Mechanical Engineer, Duluth & Iron Range

The difficulty of securing a driving box liner that can be cheaply made, easily installed, and that will give efficient service, has given railroad mechanical men considerable trouble. At one time the Duluth & Iron Range used rolled brass liners fitted into the driving boxes. After this method had been used for some time the practice was adopted of grooving the driving box faces and drilling anchor holes, then sending the boxes to the foundry, where they were laid level and moulded clay placed around the groove, the brass being cast in thick enough to leave plenty of stock for finishing. The boxes were then returned to the machine shop and planed down to the required thickness. This method made a good job, but was found to be too expensive due to the high cost of material and the amount of labor required.

Eventually this method was abandoned and on the larger boxes, where there is stock enough, the face of the box is grooved and ¾-in. holes bored through the face. Fibre liners held in place with brass plugs driven tightly in the ¾-in. holes solved the problem. The application of these liners is shown in the drawing. The shape of the liner is laid off on the fibre sheet and sawed out on the band saw, so that it requires no extra fitting, making a very cheap job and one that gives more mileage than the brass liner, at about one-third the first cost.



The Fibre Liner Held in Place by the Brass Plugs

SCIENTIFIC DEVELOPMENT OF THE LOCOMOTIVE*

Means of Securing Higher Efficiency in the Generation, Distribution and the Utilization of the Steam

BY JOHN E. MUHLFELD

PART II

IN relation to boiler feedwater, observations and experiments indicate that any scale porous to water has little effect on boiler economy. However, such scale when dried out or hardened next to the metal by the expulsion of the carbonic acid, as usually occurs when boilers are forced, will not only become an excellent heat insulator and cause a heat loss of about 10 per cent when ⅛ in. thick, but it exposes the sheets and staybolts to overheating and "mud burning," with resulting leakage and shopping for repairs and cleaning.

In view of the increasing size of locomotive boilers and the high ratings to which they are subjected, the importance of purifying unsuitable water to prevent incrustation, corrosion, leakage and burning, as well as to eliminate delays and cost of cleaning, repairing and extra fuel consumed, cannot be overestimated.

Boiler Feedwater Purifying

When an adequate and suitable supply of boiler feedwater cannot be obtained from the usual sources, then the proper treatment of the available unsuitable water becomes necessary by settling; filtration; chemical treatment in treating plants, supply tanks or tenders; or, in the case of suspended matter and carbonates, by partial purification in a combination open and closed type of exhaust-steam feedwater heater on the locomotive.

While the supplying of suitable natural or treated boiler water to the locomotive tender is the most satisfactory and economical method, in the absence of such the tender treatment or feedwater-purification method will be an improvement over feeding the raw water into the boiler without treatment, or attempting to treat it in the boiler.

Fuel

The principal fuels now used in steam locomotives are the commercial grades of bituminous and anthracite coal and fuel oil.

Regardless of the kind of fuel now used by steam locomotives, more general attention is being given to its proper preparation for the class of service to be performed and the method of firing to be followed, before it is supplied to tenders. However, the factors of kind and size of coal and method of firing must each be carefully considered and coordinated in order to insure the best results.

Combustion

The capacity of the average steam-locomotive boiler is dependent upon the activity, temperature and radiation of combustion, which in turn are usually controlled by the limitations of combustion when fuel is burned on grates, the furnace volume and evaporating surfaces, the length of the boiler flues, tubes and bafflewall arrangement, and the draft, and not so much upon the inability of the evaporating and superheating surfaces to absorb the heat.

The combustion rate generally follows the increase in draft until about 100 lb. of bituminous and about 50 lb. of anthracite coal are burned per square foot of grate area. After this the additional coal supplied is not effectively consumed due to the difficulty in supplying sufficient air, uniformly distributed, through the grates and fuel bed to oxidize the fixed carbon and volatile matter in process of combustion without a large excess of air such as obtains when forcing takes place, and it becomes necessary to open the fire door so that combustion can be completed by the admission of air above the fuel bed.

The greatest loss in heat is that due to the heat carried off in the stack gases, sparks and cinders, which usually results in a smokebox temperature of from 500 to 750 deg. F. for the best practice. Adding to this the heat losses due to combustible in ash, vapors of combustion, carbon monoxide and otherwise, leaves an average of from 25 to 40 per cent of the heat in the fuel as fired unabsorbed by the boiler and superheater.

Where locomotives are worked at from 25 to 35 per cent cut-off and hand-fired, with a thermal efficiency of about 65 per cent for the combined boiler and superheater, the heat balance will be approximately as shown in the following table.

	Per cent
Heat absorbed by boiler	55
Heat absorbed by superheater	10
Heat loss in smoke box gases	14
Heat loss in cinders	8
Heat loss in vapors of combustion	4
Heat loss in combustible in ash	3
Heat loss in carbon monoxide	2
Heat loss in radiation and unaccounted for	4
Total	100

However, at high rates of boiler capacity and draft, when stoker-fired coal is burned on grates the front-end and stack cinder and spark losses will run as high as from 12 to 25 per cent, the carbon monoxide from 2 to 7 per cent, and the unburned fuel from 10 to 35 per cent. With the best hand firing, when using dry bituminous coal averaging 14,400 B.t.u. and 60 per cent fixed carbon, 32 per cent volatile and 8 per cent ash, the fuel rates in Table 1 will usually obtain.

TABLE 1. CONSUMPTION OF DRY BITUMINOUS COAL BY LOCOMOTIVE WITH THE BEST HAND FIRING

Total indicated horsepower of locomotive	Dry coal per i. hp.-hr.
500	2.8
750	2.7
1000	2.6
1250	2.5
1500	2.6
1750	2.8
2000	3.0
2250	3.2
2500	3.4

As the locomotive firebox, which in the best practice represents only from 7 to 10 per cent of the total boiler evaporating surface, must generate all and absorb from 30 to 40 per cent of the heat energy that is converted into drawbar horsepower, the fuel effectively consumed, not fired, is the measure of work done. Therefore the largest permissible combination of fire box and combustion-chamber volume, heating surface and grate area should be provided and equipped with an arrangement of firebrick baffle walls placed on water-circulating supports in a manner to produce long flame travel, high firebox temperature and the maximum radiant heat for absorption by the surrounding water.

With the usual limitations in firebox volume, too much

*The first section of Mr. Muhlfeld's paper, which was presented at the annual meeting of the American Society of Engineers, appeared in the January issue of the *Railway Mechanical Engineer*.

importance cannot be placed on the arrangement of heat-absorbing and radiating walls for the purpose of flame and radiant-heat propagation. Carefully conducted tests have shown that the best results are obtained from solid firebrick baffle walls and that the unburned-gas, coal-dust, spark, cinder and smoke losses are reduced with an increase in their length and gas-passage arrangement, and a saving of from 10 to 15 per cent in bituminous coal as fired is effected.

The greatest difficulty in controlling combustion occurs at high horsepowers and long cut-offs, where grates are used, and for the best results the air openings should be equal to about 50 per cent and those in the ashpans to about 15 per cent of the total grate area so that firebox temperatures of from 2,000 to 2,500 deg. F. can be obtained and the unburned solid fuel, carbon monoxide and excess air over the fuel bed reduced to the minimum.

Other important factors influencing combustion, as well as evaporation and superheating, that should receive consideration are: ratios of length to diameter of boiler flues and tubes and the spacing between them; distribution of gas area between boiler flues and tubes; the effect of closed superheater dampers on firebox draft when locomotive is not using steam; free pasage of gases through front end by elimination of unnecessary baffles, steam pipes and superheater parts; arrangement of exhaust stand and nozzle to change form of exhaust jet and produce greater entrainment of gases and improved co-ordination of exhaust jet and stack.

Boiler Water Ciculation

Water is practically a non-conductor of heat but expands when heated above 39 deg. F. and rises due to its relatively lower specific gravity. Unimpeded circulation will therefore increase its ability to take up heat, maintain greater uniformity of temperature throughout the boiler, and decrease the liability of incrustation of heat-absorbing surfaces and of priming.

In designing a boiler it is extremely desirable to secure the most rapid circulation practicable, as with high combustion rates and temperatures and the abnormal state and behavior of the water film in contact with the heating surfaces, the load on the firebox sheets is very intense, the conduction rate averaging from 75,000 to 100,000 B.t.u. per square foot of evaporating surface per hour.

Therefore, in order to avoid resistance to heat transfer, with resultant overheating of metal and reduced efficiency, a relatively high velocity of circulation and at least a rate of 125 ft. per min. in the most sluggish locality is very essential.

The average locomotive boiler, with its combination of cylindrical and box shell, water legs, staybolts and rods, flues, tubes and generally irregular design of water spaces does not present ideal water-circulation possibilities, but the enlarging of contracted spaces, increasing of water-leg, flue and tube clearances, and provision of suitable outlets from choked water pockets will not only reduce the resistance to the "slip" of the steam bubbles through the water, but will enable the accelerated action of the former to increase the velocity of the latter and thereby improve general circulation and heat-transfer results.

Heat Radiation, Convection and Conduction

The transmission of the heat of combustion produced in a locomotive boiler is by means of radiation and convection to the firebox, flue, tube and superheater heating surfaces, by conduction to the water in the boiler and the steam in the superheater, and by convection through the boiler water and the superheater-steam mass. In addition there are the direct radiation losses, which in many instances are considerable.

Heat Radiation. In a locomotive boiler the efficiency of combustion heat transfer through the firebox plates and boiler flues and tubes is from 20 to 25 per cent greater as applying to those heating surfaces directly affected when subjected to the radiant effect of the incandescent combustible and non-combustible particles which have passed through the minimum distance, than the heat-transfer efficiency when convection only is available. For example, when coal is hand or stoker-fired and burned on grates or in retorts the radiant heat is at a minimum and applies only to the heat-absorbing surfaces adjacent to the fire bed while the heat of convection is at a maximum; whereas when the coal is burned in pulverized form in suspension this condition is reversed, as is evidenced by the intense incandescent flame which obtains not only in the furnace and combustion chambers of the firebox proper, but well into the boiler flues and tubes. The locomotive boiler of the future will undoubtedly depend more largely on radiant heat.

With respect to the loss of power through radiation to the atmosphere from all parts of locomotive boilers and machinery that are generators and containers of heat and pressure—to prevent which rather indifferent efforts have as yet been put forth, as the rate at which this loss of heat extends will depend upon the difference between the temperature of the body emitting the heat and the temperature and velocity of the surrounding atmosphere, there is sufficient justification for completely and properly lagging the boiler, firebox, cylinders and heads, steam chests and all other radiating surfaces, as well as for polishing certain machinery parts, in order to reduce the dissipation of heat that now takes place through these parts from the existing steam pressures and superheat.

Heat Convection. In the locomotive boiler convection acts particularly in the transfer and diffusion of the heat in the products of combustion throughout the firebox, flues, tubes and superheater by means of the smokebox draft and in the carrying of the heat through the boiler-water mass by the currents produced by circulation. In the present locomotive boiler by far the greatest proportion of the heat is imparted to the boiler evaporating and superheater surfaces by convection.

To secure the fullest benefit from heat convection the combustion volumes and gas areas must be so co-ordinated as to establish a "velocity pressure" or "frictional" action between the gases and the heat-absorbing plates and tubes in order to increase the rate of heat transmission. Likewise must the boiler circulation be expedited in order to quickly disengage and release the steam bubbles from the water side of the same plates and tubes in the final heat transfer. The possibilities for improving heat transmission by convection in the locomotive boiler with its high water rate, *i. e.*, a boiler horsepower for an average of less than two square feet of total evaporating surface, fully justifies additional study.

Heat Conduction. In the locomotive boiler heat conduction is principally associated with the thermal conductivity of the firebox, flue, tube and superheater materials and with the accumulation of soot and scale on the fire and water or steam sides, respectively. Any increase in the rate of external conductivity, considering the present kinds and thickness of firebox, flue and tube materials as practically fixed, must be through an increase in the rate of flow of the heated gases, and this in turn means the expenditure of a greater amount of energy to pull these gases through the boiler.

However, questions as to the proper gas areas, rate of flow of gases, best sizes of flues and tubes for the maximum rate of heat transfer, and relating to like factors should be carefully analyzed in order that the highest absorptive efficiency may be obtained, not only with the high but also with the low gas temperatures. While there is no difficulty in now obtaining a boiler horsepower from each 1½ to 2 sq. ft. of total evaporating surface, whatever further improvement can be made in this direction will provide just that much more margin of boiler over cylinder horsepower requirements and produce a corresponding gain in efficiency.

Steam Generation

Efficient absorption of heat for the generation of steam in the modern locomotive boiler can be more readily provided for than can suitable feedwater, effective boiler-water circulation, efficient combustion or the maximum pounds of dry saturated steam per hour, which latter is a fundamental requirement.

In present locomotive operation the quality of the steam, *i. e.*, the percentage of vapor in a mixture of vapor and water, is one of the most important and least-referred-to factors in road and laboratory test reports, particularly as the average modern locomotive boiler is notorious for delivering saturated steam to the superheater or to the steam pipes with a high percentage of entrained moisture. This is due largely to the relatively small steam space in the boiler, the close proximity of the water level to the throttle valve and the backlash due to the firebox tube sheet, and also to the fact that the most rapid movement of the steam is next to the throttle valve so that any water coming near it is immediately entrained, due to the high velocity.

Road tests recently conducted on modern Mikado types of locomotives showed an average quality of from 94.7 to 96.3 per cent for the saturated steam as delivered to the superheater, indicating from 5.3 to 4.7 per cent of moisture, which is valueless so far as its power for doing work is concerned but which greatly increases the work to be performed by the superheater by throwing upon it work which should properly be done in the boiler.

The delivery of dry saturated steam from the boiler is an item that has been given but little consideration in steam-locomotive practice, the principal idea having been to produce evaporating capacity and depend upon the superheater to perform auxiliary boiler functions. Many changes can and should be made to improve this condition.

Steam Pressure Increase

One of the greatest and simplest improvements to be made in the steam locomotive can be effected by an increase in the boiler pressure in combination with greater quantity and better quality of saturated-steam production, higher and more uniform superheat, and compounding.

While the loss in steam pressure between the boiler and the valve chests of saturated-steam locomotives is considerable, this loss is substantially increased in a superheated-steam locomotive. Tests have indicated that the loss in boiler pressure at the valve chests when working at low rates of speed and cut-off will be about 5 per cent, at medium rates about 10 per cent, and at high rates about 15 per cent.

During recent years stationary-boiler engineers have not only determined upon their efficiency but have inaugurated the use of relatively high steam pressures, and with the urgent necessity for keeping the cylinders as small in diameter and the reciprocating and revolving parts as light as practicable, there would appear to be no good reason for not now utilizing saturated steam of 350-lb. pressure, which, in combination with 300 deg. F. of superheat, should provide, in addition to the many other advantages, a much greater opportunity for economy in power generation.

Steam Superheating

The use of superheated steam has done more to increase sustained hauling power, reduce fuel and water consumption and increase thermal efficiency than any of the other means and methods that have been generally adopted on the steam locomotive since its introduction, either singly or in combination. Sustained hauling capacity is increased, due to the longer cut-off possible at comparative speeds and fuel and water economy result from the elimination of cylinder condensation, the increase in efficiency being progressive and in proportion to the amount of superheat up to the point at which the exhaust steam begins to show superheat.

With the average superheat now used, from 175 to 250 deg. F., the drawbar pull at a speed of 20 miles per hour is increased about 15 per cent; and at 50 miles per hour about 40 per cent; and, due to the combination of superheat, larger diameter of cylinders and reduced cylinder back pressure, resulting from the use of superheated steam, it is possible to increase train tonnage about 30 per cent at speeds of about 30 miles per hour.

In the best existing steam-locomotive practice the superheat generally increases with the cut-off up to 50 per cent cut off, beyond which there is usually a falling off in the superheat. Furthermore, with short cut-off a fair water rate, *i. e.*, about 19 lb. per i.hp., can be maintained; but if the cut-off at the same speed is increased to over 50 per cent the superheat must be increased to about 300 deg. F. in order to maintain the same water rate, or otherwise, for example, at 67 per cent cut-off, the steam consumption will increase to 21 lb. or more per i.hp. This for the reason that as the amount of superheat is increased the range of temperature in the cylinder during the stroke of the piston is decreased, until with sufficient superheat the changes in temperature cease entirely.

While the increased superheat results in a greater number of B.t.u. being exhausted from the cylinder, any such loss of a marked degree is more than offset by the smaller amount of heat exhausted per stroke, due to the fewer B.t.u. admitted to the cylinder per stroke at a given cut-off.

The use of highly superheated steam results in a saving of about 35 per cent of the total water evaporation per unit of power and in from 10 to 45 per cent saving in fuel, when using steam, depending upon the power output.

Existing fire-tube superheaters produce the maximum superheat only when the locomotive is forced to its boiler capacity, whereas the maximum economy is more desirable when the locomotive is working under average conditions at economical cut-offs and when the superheater should give as nearly as possible a uniform degree of high superheat under all conditions of working, regardless of the boiler evaporation. For example, if the degree of superheat obtainable at speeds of 50 miles per hour with 50 per cent cut-off could be obtained at 25 per cent cut-off, a water rate of considerably less than 15 lb. could be obtained, as compared with existing rates of about 19 lb. Therefore, as the present limitation in the hauling power of the modern superheated-steam locomotive is the capacity of the boiler to produce continuously sufficient dry saturated steam of high pressure and of the superheater to maintain a uniform high degree of superheat, the possibility of improving it by means of average higher boiler pressures and superheat temperatures and better utilization of fuel, steam and waste heat, in combination with radical changes in the design and arrangement of the boiler and superheat equipment and in the saturated- and superheater-steam connections, offers one of the greatest opportunities to increase efficiency and economy. This applies particularly to the larger locomotives, many of which consume more fuel and water and do less work than the small locomotives of the same general design and equipment.

The proposed changes, while applying especially to the production of greater efficiency at economical cut-offs for maximum power and speed, would also improve the maintenance and operation of superheaters, boilers, flues, front ends, valves, cylinders, and exhaust nozzles and provide for the better equalization of a lower draft through the flues and tubes, lower front-end temperatures, less throwing of smoke, sparks and cinders, and lower cylinder back pressure, all of which would reduce loss of power, fuel consumption and wear and tear on machinery.

Some of the particular troubles reflected in both maintenance and operation, due to the existing, generally used boiler and superheater equipment, may be stated as follows:

a Air leaks around outside steam pipes where they pass through the front ends, resulting in steam failures, burning out of front ends, reduction in the size of exhaust nozzles for the purpose of making engines steam, and increased water and fuel consumption. *b* Joints between superheater units and the saturated and superheated chambers of the headers leaking, and the cutting out of the units at the neck, between the ball joint and the tube. *c* Too little water and steam space over top of firebox and combustion-chamber sheets and flues, particularly on grades and curves, contributing to lower superheat temperature and cylinder efficiency, and to superheater-unit tubes distorting due to entrained water being carried over with the saturated steam from the boiler to the superheater, causing obstructions in and damage to superheater tubes and obstructions at the header. *d* Extreme losses in steam pressure between boiler and steam chests. *e* Boiler flues clogging, due to ash and cinders packing in around return bends and centering clamps and tubes.

Some of the points to be considered in correcting existing deficiencies may be stated as follows:

Steam Temperatures. The steam temperature should be uniform for the variable speeds and capacities of operation. At the present time high temperatures obtain only at high speeds and capacities. A minimum temperature of 650 deg. F. quickly after starting, and of 700 deg. at maximum power and speed, would be much more effective and economical. For example, a locomotive equipped for generating 350 lb. steam pressure and 300 deg. superheat, representing a total temperature of about 736.4 deg. F., will, as compared with one using 200 lb. steam pressure and 300 deg. superheat—representing a total temperature of about 687.9 deg. F., require an increase of only 18 B. t.u., or 1.3 per cent in total heat in the steam, and an increase of only 48.5 deg., or 7.05 per cent in the temperature of the steam to produce an increase of 150 lb., or 75 per cent in the steam pressure.

Dome or Steam Outlet. This should be fitted with baffles for the purpose of reducing liability of priming and entrainment of water with saturated steam.

Saturated-Steam Delivery Pipe. This should be located outside of the boiler and be of adequate cross-sectional area to reduce steam-pressure losses.

Steam Trap or Separator. A steam trap or separator should be installed between the saturated-steam delivery pipe and the superheated saturated-steam chamber for the purpose of further eliminating moisture and condensation from the superheated units and also as a re-evaporation chamber.

Superheater Header or Saturated- and Superheated-Steam Chambers should be removed from the interior of the front end.

Superheater Units should consist of not more than two tubes per boiler flue and should be of such design and arrangement as will admit of location close to the top of the flue, in order to permit free passage for cinder and ash and cleaning of flues.

Unit Joints to Saturated- and Superheated-Steam Chambers. Unit joints should be removed from the direct path of gases and cinders so as to avoid cutting out, and should be supported in a positive, equalized and flexibly yielding manner to prevent leakage due to the loosening of one joint causing the loosening of another and so that the joint bolts can be tightened at the top of the header castings.

Superheater Dampers. These should be kept in good operating condition, so that when the steam ceases to flow through the superheater units the products of combustion will stop flowing through the superheater flues, particularly when drifting at high speeds.

Steam Delivery Pipes from the Superheated-Steam Chamber should be made of adequate cross-sectional area to reduce steam-pressure losses and removed from the interior of the front end, so that no joint where they pass through the front end will be necessary.

Automatic Saturated-Steam Supply When Drifting. This is essential to eliminate the human element and insure a proper supply of saturated steam with the superheated steam just before the throttle closes and continuously thereafter. A jet of saturated steam should also be supplied to the exhaust nozzle to neutralize the gases ordinarily drawn through the same into the valve chests and cylinders.

Modern types of locomotives have developed at low speed 3,000 i.hp. and at high speed 3,200 i.hp., and comparative average water rates through the complete range of the effective capacity of the locomotive, with piston speeds of from 600 to 1,000 ft. per min., have been obtained, as shown in Table 2. At piston speeds of less than 600 ft. per min. the water rate of the double-expansion saturated-steam locomotive will approximate that of the single-expansion superheated-steam locomotive.

Table 2—Comparative Water Rates of Locomotives When Using Saturated and Superheated Steam

Cylinders	Steam	Water rate per i.h.p.-hr., lb.
Single expansion	Superheated	16 to 20
Single expansion	Saturated	24 to 29
Double expansion	Superheated	15 to 18
Double expansion	Saturated	19 to 22

Compounding. With the exception of the Mallet articulated type of compounding, the multiple-expansion system of steam utilization, which has been so successful in marine and stationary practice, has not made the progress in this country that it has in Europe.

The failure of various types of cross, four-cylinder, four-cylinder balanced and tandem double-expansion locomotives, introduced from 25 to 15 years ago, to produce the predicted economy was due largely to factors of indifferent design, low boiler pressure, excessive condensation, lack of proper maintenance and operation, poor fuel and road failures. Clearance limitations also restricted the size and arrangement of the low-pressure cylinders, while at the same time the single-expansion-cylinder superheated-steam locomotives gave opportunity for greater hauling capacity and economy.

The three-cylinder compound has frequently been advocated owing to the allowable reduced cylinder diameters and piston thrusts and a more uniform turning moment, but its use has been deferred owing to central main-rod and axle complications.

There is no doubt but that a properly designed superheated cross-compound locomotive embodies many advantageous features, such as greater starting and hauling capacity per unit of weight, less evaporating surface per indicated horsepower, reduced fuel and water consumption and less boiler repairs, and that it will return to favor for freight service in combination with higher boiler pressures and superheat, due to the necessity for greater drawbar pull and horsepower and for utilizing all superheat before its final exhaust.

By eliminating the disadvantages of the outside valve gears now in use and adding certain improvements for the purpose of increasing the ratio of expansion and shortening the ratio of compression, the tractive effort can be increased at least 10 per cent at all points of cut-off and the fuel consumption reduced 5 per cent through ability to develop the same drawbar pull with a shorter cut-off. Such a change will add greatly to the efficiency of the steam locomotive.

Where compound cylinders are used a steam expansion regulator should be incorporated with the motion gear to effect the automatic independent adjustment of the cut-off for each of the high and low-pressure cylinders for the purpose of obtaining certain cylinder ratios, and at the same time bring the cut-off in harmony at the center of the quadrant. By this means the ratio between the high and low-pressure cylinders, which, for example, should properly be 1 to 3 at starting, can be brought to 1 to 4 at cut-off, thereby

insuring easy exit of the exhaust steam from the low-pressure cylinder and at the same time automatically distributing the work properly between the two cylinders at speed. In this way a compound locomotive of the Mallet articulated type can be made to develop at least 55 per cent of its rated tractive power at a speed of from 8 to 10 miles per hour, when operating at 25 miles per hour, and there will be a gain in tractive power of about 15 per cent at 25, and of about 10 per cent at 30 miles per hour. In fact, a drop in the drawbar pull in a Mallet articulated compound locomotive on account of speed should not materially increase beyond that of a single-expansion engine.

Cylinder Clearance. The inauguration of the use of the inside-admission piston valve and of superheated steam has brought with it the wasteful effects of larger cylinder clearance, due principally to the use of a valve of too large diameter and an indifferent design of valve chest and ports in combination with the cylinder castings. To somewhat overcome this trouble the piston valves were increased in length, with subsequent breakage of castings through the vertical ports, particularly as the result of water from condensation and unstayed flat surfaces.

The use of smaller-diameter piston valves located close to the cylinder and connected with properly designed expanding steam ports will, in combination with improved material and workmanship, correct these generally existing deficiencies.

Cylinder Back Pressure. About 75 per cent of the cylinder back pressure is due to the use of the exhaust steam to produce draft for combustion, evaporation and superheat. Assuming that for every 100 hp. in steam used only 60 per cent is utilized in producing actual tractive power, then 40 per cent is wasted through the exhaust, of which 75 per cent is chargeable to steam and superheat generation.

Much remains to be done in the way of enlarging exhaust-steam openings from the cylinder to the atmosphere and in reducing existing sharp turns, cramped passages and obstructions to the free passage of steam through them; and also in the development of an exhaust stand and nozzle that will combine the advantages of the single and double types. It has been found that by enlarging a 5½-in. diameter exhaust nozzle to 5¾ in., or about 9.3 per cent in area, fuel consumptions have decreased from 15 to 20 per cent, depending upon fuel and weather conditions, and that the locomotive efficiency has been increased from 10 to 15 per cent, depending upon cut-off and speed.

Valves and Cylinders. Inside-admission piston valves, although inherently deficient with respect to water and compression-relieving capacity, have many advantages, particularly for superheated steam, and the application of double-ported valves for low-pressure cylinders has worked out satisfactorily.

Various tests and many years' experience have demonstrated through the better use of steam and the resulting reduction of jerking, pulling and stresses on valve stem and gear, unbalanced pressure, frictional contact, valve and bushing wear, leakage and lubrication, the practical advantages of a minimum diameter and weight of valve with the circumference no greater than the length of a slide-valve port and with every inch of bushing port made effective and designed in conformity with the well-known principles governing the flow of gases so as to eliminate eddies and baffling in the steam flow which occurs in the passages between valve and cylinder.

In addition to reducing the weight of a valve by reducing its diameter, it can be further lightened by using a smaller spool, as experience has proven that with simple cylinders an area of opening through the valve body equal to one-half the area of a single exhaust-nozzle orifice is sufficient to obviate the hammering of the exhaust steam on the valve ends. With cross-compound cylinders the conditions are even more favorable, due to the receiver pressure. Furthermore, there is still a possibility of considerably reducing weight in bull-ring and follower designs, which will further reduce the stresses in valve rods and gears that have been found to increase with the speed, cut-off and weight of valve.

There is also considerable opportunity to improve packing rings by locking and putting them in absolute steam balance, preventing exhaust rings from collapsing under compression or being forced from grooves into ports between bridges, and stopping leakage of live steam to the exhaust side of the valve. Extended rods and carriers for the front ends of both valves and pistons have also been found essential to the best results. Two refined-gray-iron packing rings should be sufficient for all pistons, and two-piece one-ring piston and valve-rod packing of a suitable aluminum alloy should be satisfactory. Wherever possible the center line of each cylinder, under normal working condition, should be in horizontal alignment with the centers of the driving axles. All cylinders should be equipped with suitable types of by-pass valves.

Piston Speeds. Frequent errors have been made in not properly proportioning the driver-wheel diameter and stroke of the piston. Slow speed and high ratios of expansion are factors particularly favorable to superheated steam, and piston speeds of from 700 to 1,000 ft. per min. will insure the best results.

Waste-Heat Distribution and Utilization

As a reasonable estimate would show that 40 per cent of the heat in the steam and in the products of combustion is exhausted from the stack, any considerable part of this heat that can be reclaimed for preheating boiler feedwater will add greatly to the overall efficiency of the locomotive and to the saving in fuel. The principal means through which to accomplish this saving, in a practical way, are exhaust-steam heaters and flue-gas economizers, both of which can be readily adapted to a modern steam locomotive.

Exhaust-Steam Heaters. With the many steam-using auxiliaries, such as those for air compressing, boiler feeding, valve-gear operating and electric lighting, which operate when the locomotive is standing, drifting or working, a combination open and closed type of feedwater heater and purifier for the utilization of the exhaust steam from these auxiliaries, supplemented if necessary by steam from the main engine's exhaust, should receive prompt consideration.

From actual service tests of closed types of heaters, made on modern superheated-steam locomotives, using a portion of the main-engine exhaust steam only, it has been found that a feedwater temperature approximating 240 deg. F., or within 15 deg. of the exhaust-steam temperature, can be obtained without interfering with the draft required for maximum steam and superheat generation.

Flue-Gas Economizers. Owing to the high rate of combustion and evaporation and in the process of superheating, much heat is usually wasted, as the gases from which the steam receives its heat must be hotter than the steam itself. The higher the steam pressure the less is the average difference in temperature between the gases of combustion and the contents of the boiler, therefore the slower the transmission of heat the greater the work of the economizer may be. Likewise the lower the efficiency of the boiler will be if it is not supplemented by an economizer.

An economizer will heat the feedwater to a higher temperature than an exhaust-steam heater and will recover most of the waste heat resulting from high steam pressure and high superheat, as it is able to recover low-temperature heat that has escaped from the boiler evaporating or superheater surfaces because the average temperature of the feedwater within the economizer, which should, if practicable, be

brought up to the boiler evaporating temperature, is much lower than the temperature of the water in the boiler.

As locomotive smokebox superheaters, now obsolete, have demonstrated that 50 deg. of superheat may be obtained from flue gases at 600 deg. F., there should be no difficulty in devising a locomotive economizer that will produce very effective results, in combination with high boiler pressures, superheat and draft, without baffling the boiler draft and evaporating capacity. In fact, with an average boiler efficiency of 60 per cent and an economizer efficiency of 50 per cent, the possibility of recovering from 25 to 50 per cent of the stack gas loses and thereby increasing the thermal efficiency of the entire unit is well within the limits of possibility.

DISCUSSION

F. J. Cole (American Locomotive Company) took issue with many of Mr. Muhlfeld's statements. He cited the fact that a modern locomotive will produce a horsepower-hour on less than two pounds of coal to prove that the locomotive is an economical power plant. He stated that the usual design of locomotive boiler is not suited for a pressure of 350 lb. and much remained to be done in the way of designing boilers to safely operate under high pressures. Mr. Cole pointed out that by the use of trailing wheels the boiler design is improved and higher efficiency secured. He thought it doubtful whether increased water volume would add to the efficiency of the boiler, but pointed out that attention should be given to details of domes and throttle valves to prevent water being carried over into the dry pipe. He also stated that while the high cost of coal undoubtedly justified the introduction of devices that increase capacity and economy, the greater maintenance cost resulting from their use must be considered in judging the relative merits of specific devices.

Clement F. Street (Locomotive Stoker Company) questioned the data Mr. Muhlfeld submitted regarding the cost of electric operation and defended the performance of locomotive stokers.

H. B. Oatley (Locomotive Superheater Company) stated that the program of improvement laid out by Mr. Muhlfeld was not entirely practical as regards economy, though almost ideal from the standpoint of the generation and utilization of steam. He stated that with the proper design of boiler a steam pressure of 500 lb. would prove both safe and economical, and stated that condensing operation was not beyond the realm of possibility. Mr. Oatley also expressed the belief that the present method of transmitting power would be superseded by an improved type of construction that would result in the elimination of considerable unbalanced reciprocating and rotating weight and consequently in less rapid deterioration of the rail, the rail bed and the driving mechanisms.

Otto S. Beyer, Jr., stated that the possibilities for economy of the super-power plant, located in the coal district itself and doing away with fuel haulage, should be considered. He believed that speed in railway operation, which in turn would mean faster locomotives, will be required more and more in the future.

E. B. Katte (New York Central) disagreed with Mr. Muhlfeld's conclusions regarding the obejctions to electrification. He stated that experience had proved that the capital cost was not prohibitive, that electric operation had been demonstrated efficient, economical and reliable for every class of service. He pointed out that electrification increased the capacity of tracks approximately 30 per cent and that while the first cost of the electric installation was higher than for a steam operated road, the operating cost was less with the electric equipment.

George Gibbs (Gibbs & Hill) stated that the author was mistaken in his belief that electric traction had not given the desired results. More money had been made for the stockholders by reduced operating expenses or by producing new business either by more attractive or more reliable service or by an increase in the capacity of the railway's facilities as a whole.

Mr. Muhlfeld in closing said that in the boiler being designed for higher pressures the largest diameter of the shell, which was made of 1¼-in. plates, was 68 in. This was about as large a boiler as could be handled at present by locomotive builders. Mr. Oatley had referred to 500 lb. pressure. What had limited him in his argument in the paper to 350 lb. was the cylinder temperature, not boiler troubles, and tests made during the past three years had shown that a higher temperature than 750 deg. F would be one that would destroy the cylinders, as well as the packing and bushings.

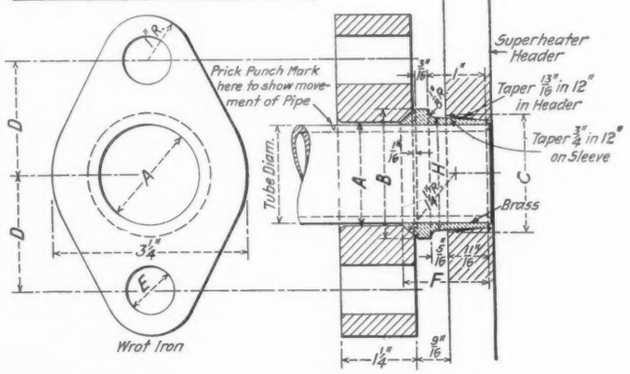
In the matter of burning coal, to which Mr. Street had referred, he would say that during the past five years he had made numerous tests of the cinders taken from the back of a stoker-fired locomotive and from accumulations in small boxes placed on top of a freight train, and had found that in nearly every case they were unconsumed particles of fuel. The coal was being put through the boiler but was not being burned.

In regard to questions propounded by James H. S. Bates and William H. Wood, he would say in reply to the former that the steam turbine had not as yet been adapted to the locomotive, and to the latter that fireboxes with flexible stays were being eliminated.

TAPERED JOINTS FOR SUPERHEATER UNITS

In superheaters with spherical ground joints a high tension on the bolts securing the elements is necessary to avoid leaks. An interesting type of joint designed to overcome this difficulty, which has been introduced on the Great Northern, is shown in the drawing below. The superheater units have brass sleeves, fitting tightly over the tubes. After the sleeves are in place the ends of the elements are peened out slightly

H	F	E	D	C	B	A	Tube Diam.
1 1/2"	1 3/8"	15/16"	1 7/8"	1 1/2"	1 3/8"	1 7/16"	1 5/16"
1 5/8"	1 7/16"	15/16"	1 7/8"	1 5/8"	2 1/16"	1 9/16"	1 7/16"
1 13/16"	1 7/16"	15/16"	1 7/8"	1 13/16"	2 3/16"	1 3/4"	1 5/8"



Type of Joint Used On Emerson-Yoerg Superheater

to hold them securely. The end of the sleeve is finished with a taper of ¾ in. in 12 in. while the opening in the header into which the sleeve is fitted has a taper of 13/16 in. in 12 in. This slight difference in the taper causes a powerful wedging action when the gland is drawn up and insures a steam tight joint. This type of sleeve has been used with excellent results on the Emerson-Yoerg superheater.

WHAT IS WRONG WITH RAILROAD MANAGEMENT?

Complication but no System; Neglect by Railway Officers Causes Loss of Interest by the Workmen

BY FRANK ROBERTS

EFFICIENT transportation depends in part upon well-kept motive power. The physical condition of motive power to effectively do its work depends upon several factors. First, an efficient, able, interested, co-operative official organization; and, second, a well managed, fully stocked and properly equipped enginehouse. The third is further removed from the daily routine, or from direct touch and actual operation. The general locomotive repair shops are truly the general hospitals, in which all real operating disorders are corrected, the source of all emergency heavy repair parts, and the place where the real upkeep is handled.

I make this introduction for the purpose of coming down to the conditions prevailing in railroad repair shops and to show the methods that are tolerated. Extravagant inefficiency, which would ruin Henry Ford if introduced into his shops, is overlooked in railroad shops and covered up with an annual appropriation and forgotten, the same as a wealthy parent makes an allowance to a boy at college and then forgets it. We get some idea of this waste as we read how Uncle Sam lost $1,000,000 a day while operating our railroads.

From what appears in our daily papers, or what we hear on the street, or observe from the car window, a person gains but little understanding of the necessity for an auxiliary such as a general repair shop for motive power.

Inefficiency of railway shop organizations due to lack of proper tools and of interdepartmental co-operation, resulting in loss of time and money.

This lack of understanding and appreciation on the part of the public is unfortunate and in about the same spirit, it would appear, the railway officers try to forget the shops. The only token that the workers in these shops have of their employer's interest in their welfare is a visit once a week by the paymaster, and perhaps late in the autumn a few workers will drop in unexpectedly and repair some of the worst leaks in the roof over their head, replace missing window lights or otherwise protect them against the approaching cold of winter. This may seem a little unfair to an outsider, but to the workmen themselves the impression is that, with the above mentioned duties performed, the officials have discharged their obligations, and locomotives should always be in fit working order to deliver their allotted ton-miles of service without the sacrifice of a single B.t.u. of heat or mechanical energy through inefficiency resulting from any possible question of repair.

The fact is, about eight per cent of the total investment of a railroad is in locomotives; that is, if the road has been properly financed. Some we know have had their capitalization so doctored up that if all the facts were generally known we would be prone to consider the venture as below water, and a marine rather than an overland proposition. This eight per cent investment unfortunately is like the dresses women wear—more expensive in the first cost; much more care and trouble to maintain and not nearly as serviceable as they were 20 years ago. For example, 20 years ago we could purchase a good locomotive for $15,000, and today a modern locomotive costs anywhere from $50,000 to $100,000. One railroad purchased some Baldwin "hogs" some 20 years ago, and it was usual in rush seasons for these locomotives, after making their daily run, to come into the freight yard with a train, disconnect, run on the turntable, head about, have the fires cleaned on the ashpit, the tank filled with water, the sand box and coal pocket filled, a new crew on hand who immediately advanced to the yard, attached to a train and made the return trip. These engines have operated under such conditions for a week at a time without ever seeing the inside of an enginehouse. The only repairs or attention they received were made by the engineman and fireman in charge. But that was during the days when everybody knew the division superintendent and all had a semblance of interest in their work. Those were days when a man was allowed to take pride in his work, and he knew that his days with the road were determined by faithful services. At that time common sense kept each worker's ambition up. Unusual ability gave unusual results, and promotion came to the faithful. If trouble came it was local and settled in a man to man fashion, and the public had all their trains during the controversy.

Complication but No System in Handling Work

Conditions have changed, not only in the matter of human relations, but equally noticeably in the motive power. Our locomotives have become so overgrown that they shake themselves apart on the road, and it is not safe to continue them in service over 100 miles. This may be news to some people who may imagine that the same locomotive draws their train from Boston to Chicago, but if they will observe the number on the cab as they board the train at South Station, Boston, and observe operations at Springfield, again at Albany and so on at about every one hundred miles, they will see a change of locomotives. The locomotive thus relieved is run into the roundhouse and a crew of men goes over it, making the repairs that the engineman's report calls for, usually considerable, including anything from a mis-set safety valve to a leaky set of boiler tubes. In addition to this there is a staff of inspectors who examine for their special parts. One looks for flat wheels or sharp tires, another for hot journals, another to test the air brakes, lubricators, etc., until every part is thoroughly inspected. If the piston rod of the air pump was leaking in olden times the engineman took about five minutes and repaired it—now he is not allowed to. He must make a report and a special workman is sent out to do the work. He may or may not make a good job of it, but it makes no difference, because another engineman will take the locomotive out on the next trip, and the air pump man in the roundhouse at the other end will give it a try.

An inspector may report a nut off a binder bolt. The machinist finally reads his work report, asks the storekeeper what size bolt locomotive No. 1100 has on her left main binder. He thinks it is a 1-in., his friend is of the opinion that it is ⅞-in., and his helper declares it is either 1⅛-in. or 1¼-in. because they put some on No. 900 last week. "All right! To be sure, we will take one of each, ⅞, 1, 1⅛, or 1¼-in. to save a trip out to find out just what size it is." This plan certainly saves steps, and they proceed into the enginehouse to locomotive No. 1100, and sure enough the

helper was right, it is 1⅛-in., and on the nut goes. But it is a waste of time and strength to take those other nuts back to the stock room, and down the pit they go. This shows the modern spirit, and if you are not yet convinced let me state that on one division, where there are only 300 locomotives, the firemen used 2,400 fire hooks in six months, or an average of a hook on each locomotive in 23 days. Where do they go? Of brakeman's lanterns 5,000 a year. Where do they go?

Present day locomotives cannot continue in service even in an emergency without considerable repairing after each trip of about 100 miles. The element of continuous service is a lost art, as well as the spirit of service that came with a day's work years ago.

Inefficient Methods for General Repairs

All the repairs thus far referred to are classified as enginehouse work. After a locomotive has made from 50,000 to 75,000 miles, usually in from 10 months to a year, it is taken out of service and given a general overhauling in the shop. Also all locomotives that have had a serious breakdown or have been in a wreck find their way back to the shop. They are dismantled or stripped, all the parts thoroughly cleaned, broken parts welded or replaced with new, all springs are heated and restored to the original dimensions and again tempered, valve gear and side rods annealed and new bushings applied, the cylinders and steam chests rebored, or perhaps new bushings applied. The piston and valve stem packing is repaired or replaced, the driving boxes equipped with new brasses and liners, the axles and crank pins turned and trued, the driver wheels turned or perhaps new tires put on, the driving box shoes and wedges refitted or perhaps replaced with a new set and the frames repaired if they are worn or cracked. The boiler must be thoroughly inspected and tested, the flues removed, cleaned and returned and welded in place. The safety valves, injectors, pneumatic firedoors, gages and gage glasses, the air brakes, valves and pump, power reverse gear, electric light generator, the superheater units, tender tank, trucks and draw gear all require a thorough rebuilding. So much for the extent and nature of repairs which are completed with the locomotive ready for trial and return to service, from which she has been withdrawn for a period varying from 16 to 30 days.

The important connection with all this is the way in which it is handled and the lack of co-operation and interest among the workmen, due in a large part to official neglect and the results of present day tendencies. The peculiar thing about railroad organizations is the fact that no man or any particular job nor any particular person can get any recognition, either for his ideas, the need for necessary material, or is provided with tools or adequate shop facilities to go ahead efficiently. If a man asks his gang leader for a new file or a piece of belting for his lathe he is told that the storekeeper is out of that material. The storekeeper informs the shop foreman that the purchasing agent has had his requisition for three months and has not placed the order, or else he is told that his letter of certain date requests that he hold back on certain items for some months, or under conditions now existing he will have to ask him to cut his stores down another 25 per cent, etc., etc. Perhaps the general foreman has been drawn in and he, through the division master mechanic and the superintendent of motive power, has learned from the general superintendent that he informed the purchasing agent to hold up purchasing anything further until January 1, because the federal authorities were expecting to turn the roads back. All this time the man on the lathe is wondering how he is to do his work, and as a natural result about all he is doing is to keep his time card filled out each day, draw 72 cents per hour, and report to his fellow workman about the loss that the road is experiencing because of lack of support and interest in the shop on the part of the officials of the company.

Antiquated Tools Cause Loss of Time and Money

I know of a case where it was proved that an improved piston packing ring gave a good many thousand miles of increase in service, over the plain snap rings, and they wanted to adopt them, but there was not a machine available to turn them up on. A new vertical boring mill was requested and the request was backed up with all the facts and the advantages to be gained, providing, as conclusively as argument could, the saving in dollars and in increased service from the packing. But all the satisfaction we obtained was, that there was no money available and no matter how great the savings might be we simply could not make the purchase. The same week a new 60-ton wrecking crane was ordered and most of the time it stands on a siding outside of the shop beside several smaller ones, waiting for service or a wreck.

The railroads will not purchase a new outfit of lathes, but continue to use some over 50 years old and are paying men modern wages to watch those antiquated curiosities feebly fooling away their time trying to do the work before them—meanwhile the operator is resigned to slow death. These same roads do not hesitate to scrap locomotives of 20 years ago and purchase modern ones, calling it good business. This may be so, but why not replace mechanical equipment in the shop that is removed more than twice as far from present day practice? It must also follow that this is just as profitable as the reasoning applied to the scrapping of the locomotives. This critical review can be carried back, in many instances, to show the neglect of railway officers in not keeping up their shops. It is certainly poor reasoning to spend ten dollars for labor when one dollar in tool service and four dollars in labor properly supported could have saved five dollars on the same job, and when this support would restore the interest of the men in their work.

I contend that railroad officials do not properly appreciate or support the repair plants.

Too Much Petty Jealousy

The railroad organizations are so cumbersome that the process of reaching the final authority is worse than climbing the Swiss mountains, and just about as likely to reach the desired end if the attempt is made single-handed by any ordinary workman. Subordinate officials or workmen dare not address a "higher up" directly or off comes his head.

There is too much petty official jealousy in the average railroad make-up. The authority is too far removed to be efficient. Everybody must see his superior and get official authority before he can act and the different departments and divisions do not co-operate properly to make railroad work attractive or efficient.

What we need is greater freedom among local officials. Lift the red tape and restraint from these officials in small matters. Give each man his work with a man's freedom and place responsibility with him for the results. Then support him with proper and necessary equipment and we will at once begin to get a lot of officials that will take on normal development, exercise their own judgment and increase their interest in their work. A change will then take place in the financial showing of all departments. What railroad men require is a greater understanding as to just what the railway officers really want or expect from them, the custom now being to keep away and show absolutely no interest in the shop except for an official visit preceded by due warning that they will come, about 10 days ahead of the time set. The poor local foremen get busy and wash the windows, whitewash the front fence, clean the waste papers from the fence corners about the place and issue instructions to "close off all air pipes in departments *A* and *B* next Monday morning until after official So and So has left, for we do not want him to

hear the escaping air (dollars) whistling from some 25 or more air hoist control valves and leaky air pipe lines."

Robbing Peter to Pay Paul

For further illustration, what would you think of management that will defer consideration of making an outlay of $500 for the purpose of digging up a sewer tile, draining 21 engine pits on the erecting floor where 200 men are engaged every day, and where it is safe to say 10 per cent of the total efficiency is destroyed because of water in the pits?—On this same erecting floor there is but one crane and men wait a whole day to lift a set of superheater units in or out, or the boilermakers stand around four or five hours waiting to transport a set of boiler tubes, etc.—Where another department will come in and rip up the floor under six or eight lathes a week before the new floor lumber is at hand? Where the purchasing agent is 100 miles away from the shop, never makes a visit or gains any first-hand information and permits an engine to remain out of service for want of parts that should always be in stock? I know for a fact of a case where a man in need of an airpump gasket stripped eight different pumps and then had to use one that he felt sure would not last a week, and remarked that the pump will be back soon though it should remain in service for a year. The enginehouse men will not attempt to fix it, but will rip it off and cry for another, and more than this, suppose air brakes fail and a wreck results, the engineman is to blame. Now, who ever heard of a purchasing agent being to blame? How utterly impossible for a purchasing agent to cause a railroad wreck. The nearest that we could possibly connect them would be in providing inferior material or forcing the continuance in service of material which is not safe, because there is no other on hand to be used. Railroads lose thousands of dollars in not keeping stocked up with necessary materials. A cent saved by being withheld from normal requirement in material is a dollar lost in time in too many cases. Suppose a man wants a ½-in. nut and spends an hour sorting over scrap to get one that fails and ties up a train for an hour. Or if he wants a ¾-in. pipe union, the piper strips a pipe off another locomotive and in doing it loses a piece of pipe three feet long, causing a loss of one and one-half hours time spent by the piper and his helper in looking for it and finally making a new pipe and robbing the second locomotive to get this same union back.

In these cases there are several things that an enginehouse foreman may do. He may lay the engine up and keep her out of service, or he may rob from another locomotive. This is practiced altogether too much, for it costs money to transfer parts from one locomotive to another, and it is not a cure for you always have one locomotive left without parts no matter how many changes you make. The expense keeps mounting until a new part finally arrives. By that time the changing around has met with a question of sizes and the part fits on in its original place. Meanwhile the changes have caused the breakage of a second part, which, if the other part had been left on in its original place, would have continued for years. Locomotives are not maintained to a standard close enough for indiscriminate changing of parts without costly breakdowns. A third plan is to send her back into service, if possible, hoping that she will make the other end of the road and there let "George" worry about it.

An enginehouse foreman makes a request for an item of material; the storekeeper looks it over. Suppose it is for eight driving box shoes for a Consolidation locomotive. The storekeeper has instructions to trim this month, so he follows instructions and orders six shoes; the purchasing agent recalls his trimming policy and off go two more. The order is placed for four. Why is it that when they are delivered to the enginehouse foreman he cannot say "Thank you, just as ordered," instead of losing interest and returning the locomotive to service with defective shoes and 40 points of defective personal feelings? He sees and knows that results like this are official failures, and that he is absolutely unable to help himself. Inefficiency in the official organization causes discord, loss of interest and expense among the workmen.

Organized Labor Dominates the Situation

As before mentioned, workers were formerly handled as a local problem and each problem had its own solution. Today conditions are different and we must consider our entire railroad system as the unit, and worse than this, various branches or trades are interlocked to bring joint pressure, if necessary, to force their demands, and railroads, under federal control, have never been courageous enough to refuse a real demand thus far.

Organized labor has the railroads by the throat and is, at this time, the cause of heavy losses through open and defiant inefficiency. For example, one shop that I know of used to have two men strip the front end of a boiler complete ready for the boilermakers, and they did it in quick time. Today that same shop has to have an electrician disconnect the headlight wires, a machinist removes the marker brackets and lamps, the boilermakers the front end door plate, spark screen and draft pipes, the machinists take out the exhaust tip and base, the boiler makers the draft plates and the machinists the superheater units and damper mechanism. The hold-up is apparent.

Now, why this organization and its inefficient agreement? Simply the limitations of human endurance. The men could not gain anything until they organized and forced it, but even after recent experiences these same officials will no more recognize a workman who loyally stood by his post and their interests by refusing to go out on a strike, than they do the worst agitator who caused the strike.

Labor organizations are all right if properly handled. We know the parent organization as the American Federation of Labor. Certainly a fine name, and we would expect American standards of patriotism to find expression among their activities. But here is where it seems to fail. I would insist first of all that none but American citizens could hold office within its ranks and all alien members should lose their voting power. No leader or agitator should be allowed to address their meetings or distribute circular matter written by any alien. If I had my way, citizenship would be necessary to gain admission to the membership and all those that are members at the present time would have to become American citizens or get out of the union. Any member engaged in disloyal activity would be expelled. In short, I would make the Federation of Labor an asset to our nation and not the propagating ground for anarchy.

How to Improve Conditions

How can we improve conditions? How can we make the railroads change about and earn not only their operating expenses, but pay a rental for the money already invested as well as to create a condition where real live workmen will take part in the work, and an investor will hazard his money in their care?

The answer is, we must study human nature, and have real live men take part in railroad administration and operation. This is evident when you look at the long line of failures that follow almost every railroad man when he leaves railroad work and tries his hand at other lines. He doesn't last long enough to make it worth mentioning. Why? Because in railroad work he was never placed where he carried any real responsibility. The "higher ups" prescribed his work so completely that he never had a chance to know what personal initiative meant as connected with him. No, he never knew what it meant to shoulder a situation and go

through with it himself, and so it goes, once a railroad man, always a railroad man, unless the "get-away" was quick and he did not fully get into the rut.

What I would like to see is the higher officials to drop their distant, aristocratic, important, special car stuff and get back to first principles, be real men again, and in good democratic fashion have, at least once a year, a banquet, picnic, or get together under any pretence, where every worker could have a chance to see and talk with his officials and listen to a real declaration of purposes and principles. Not the present code that has seeped through the blockade of unwilling chief clerks and department heads. To do this in a free manner implies, of course, that the president or ranking official is all that the job calls for, the real thing and not somebody's son or cousin, who serves as a figurehead. The time is here when we must make our railroads democratic, we must have real live one hundred per cent Americans nd practical men who have the capacity for their official tasks. The favored son or relative day is past. Officials must meet, study and understand their men and their needs. They have got to surround their subordinates with an atmosphere of hope, fair dealing and encouragment, which will create conditions for departmental co-operation. There is a world of power in the brains of the workers if their officials will permit it to come to the surface and use it.

Increased Pay Alone Not Sufficient

I am a strong believer in humanity when given encouragement and understanding, and know that increased pay or wages will never satisfy or stabilize workers anywhere. There is not a case in all history where money alone permanently satisfied human nature. It may produce conditions leading to abundant happiness, but of itself alone it only proves in the long run slow poison to manhood and individual advancement.

Robinson Crusoe threw it away. Shylock retained it and threw himself away. William Penn used it and was happy in the service that it made possible for him to render humanity. Labor organizations have constantly asked for more pay and shorter hours, better working conditions and the establishment of restrictions that have reduced the production per unit time at least 50 per cent. The encouragement given to these organizations during past two years has produced a ridiculous disrespect among the members for the very people who must pay the price for all the advantages, as well as those who granted the concessions.

Co-operation and Loyal Service

We are confronted by two problems. Inefficiency and disloyalty, and the charge is up to both officials and men equally. The relations between officials and men are just reversed. The officials seek to forsake and neglect and men try to produce as little as possible. With this condition on our hands how are we to arrive at a solution that will effectually line up all hands for loyal, full 100 per cent co-operation and service?

It must start with the officials, they must have money to purchase shops and equipment, and the men must be brought into a new spirit of appreciation of the importance of full co-operation and respond with loyal service. They can do this by proper mental discipline, forsaking outside discordant leadership, engage so fully in their work that it returns satisfaction from the consciousness of having done well, whatever the task that may be theirs. Make the shop atmosphere an asset so forceful and progressive that the officials will find more pleasure in frequent visits. They will realize that it is better business to keep their individual employees straight by personal contact, than it is to read, in the seclusion of their private office, a cold report of how many bent spikes were straightened at the scrap yard. The salvaging of scrap material is good business, but the keeping of our human factor above scrap valuations is a better official pastime and when that is realized, there will be, due to a higher degree of interest within the workmen, thousands of dollars worth of material used, that is at the present time dropped into the scrap.

But how are we to break the ice and change relations? Official abandonment has forced organization upon the employees. No better means is at hand to work out this problem than through organization. Organize how? Who? Organize all the employees of a road into one complete family of interest as loyal as a hive of bees, and let the employees have a voice in the management. When the officials need money, issue bonds of low denominations and sell them to their employees. There is all the money they need right at home—why not use this asset which has always been available, and is now. Do not cry poverty, higher transportation charges, etc. Cast off that Rip Van Winkle stuff, and let us see ourselves as others see us. When you accept an employee's money into a business that he is selling service to and has a voting power in, you get his good will, and this is worth more in actual cash to our railroads today than all the money that they measure on the deficit side of their ledgers.

I believe in myself, I believe in the future of our roads, either under private or government ownership, and I believe in our state and nation. But I am not satisfied with present day conditions or relations. I do not believe a body of Congressmen, absolutely ignorant of railroad affairs, can ever furnish the relief we need at this time to place the railroads on their feet. To further illustrate, take any business proposition and put it up to the politicians to solve. I do not think there is one man in Congress out of three and perhaps out of ten who can handle bookkeeping or can audit an account, and how can they pass reasonably on a business proposition, let alone one like the railroads. The solution is not there. Where is it? Among the railroad employees themselves. There is not a man working for any railroad in the United States, in any capacity, but has an honest criticism, and also a remedy. The collection of such material and molding it into a new plan of management will go a long way towards improving conditions all along the line, clear up to a cash balance on the proper side of our books at the close of business each month. Labor will become smoothed out and the railroads will cease to be a national danger and worry. They will furnish the service that will efficiently handle the business of the best country and nation on earth. A fair portion of this profit must come back to the man in "jeans" that has faithfully and steadfastly performed his task, no matter what it may be.

My faith in humanity is my faith in America and the solution of this problem.

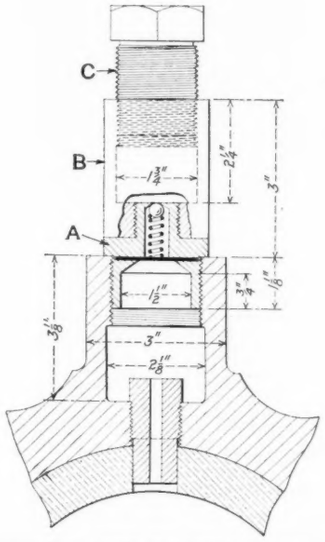
One of the Two Bays of the Erecting Shop of the A. E. F. Engineers at Nevers, France. American Locomotives on the Left and Centre Tracks. French Locomotives on the Right Hand Track.

A PLUGLESS GREASE CUP

BY J. P. RISQUE

Owing to the loss of 300 grease cup plugs and lock nuts from locomotive side rods, the mechanical department of the Florida East Coast Railroad has produced a design which has been tried on three locomotives for some time and promises to eliminate the losses referred to.

The attachment, as illustrated in the drawing, is intended



Plugless Grease Cup with the Filling Apparatus Attached

to be used on cups which are forged as integral parts of the rod. The outside threaded cap *A* is turned from a solid bar of soft steel and is made to screw into the rod cup very tightly. It is provided with a cup approximately ¾ in. deep by 1½ in. in diameter to contain the grease. The base of the coil spring, shown in section, is seated on a steel pin which is driven through from the side of the cup in the position indicated. The expansion of this spring seats the ball against the top filling hole, closing it.

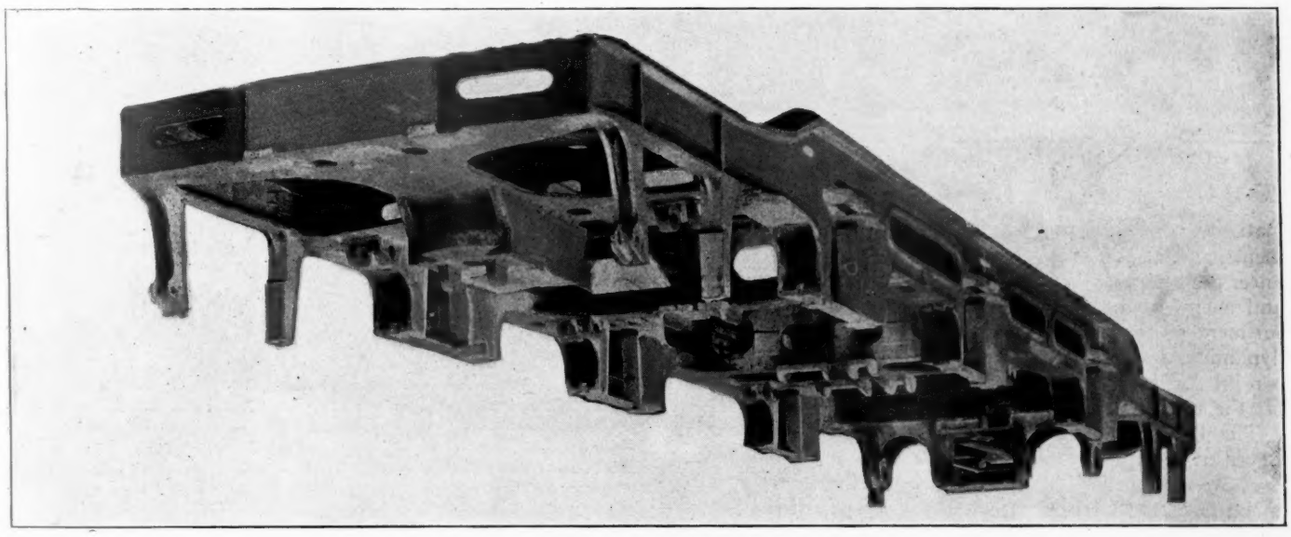
The filling apparatus consists of a special shell *B* and its force plug *C*, the former being screwed on the projection of the cup. The shell *B* is filled with a section of grease cut to the necessary size to prevent waste and the plug inserted and screwed down, forcing the grease through the filler hole against the ball and down into the cup. When the cup is filled the filling shell and its plug are removed.

The favorable reports on the performance of this cup warrant its adoption as standard by the Florida East Coast. The reports show that the first cost of the device is more than offset by the savings it has brought about, not only by eliminating the loss of plugs, but by a considerable reduction of side rod brass losses due to running hot.

ONE-PIECE CAST STEEL FRAMES FOR ELECTRIC LOCOMOTIVES

A notable example of the large and intricate parts which are successfully made of cast steel is the bed casting for the latest order of electrical locomotives built for the New York, New Haven & Hartford, illustrated herewith. In designing this locomotive the weight of the built-up frame was found to be so great that the total weight would exceed the allowable limit. For that reason the Commonwealth Steel Company, St. Louis, Mo., was asked to submit a design. The general plan for such a casting had been worked out by the company's engineering department, but the 10 beds for the New Haven locomotives were the first to be made.

The locomotive bed is 32 ft. 4 in. long, weighs 17,000 lb. and is probably the most difficult casting of its kind ever attempted. This single unit replaces a very large number of parts, greatly reducing the weight and increasing the strength. Numerous bolts and nuts have been eliminated that become loose and allow play, especially at the pedestals. This will result in a considerable saving in the cost of maintenance and repairs. This locomotive bed strikingly illustrates the adaptability of cast steel to certain types of construction. It not only provides an irregular contour of members for clearance without sacrificing strength, but also facilitates securing various cross sections of all members, correctly proportioned in size to correspond with various stresses, at the same time providing the required flexibility in the structure.



Cast Steel Bed for New Haven Electric Locomotives

During the months of January and February the Railway Age reported orders for 364 locomotives, 8,616 freight cars and 60 passenger cars for domestic service. There were also ordered 268 locomotives and 1,560 freight cars for export. In the week ending February 27, 207 locomotives were ordered for domestic service.

PRAIRIE TYPE LOCOMOTIVES FOR THE KIN-HAN

The Lima Locomotive Works has recently built for the Kin-Han Railway of China ten 2-6-2 type locomotives to be used in mixed service. This road runs from Pekin to Hankow and because of track conditions a number of difficult engineering problems had to be met in the design of these locomotives. There were very close limitations of weight for both the engine and tender. There were also rigid requirements in connection with the counterbalancing of the reciprocating parts and the locomotives were required to pass over 22-deg. curves. To meet these conditions and produce a satisfactory design of locomotive required great care in designing and construction. The engines have been built and fully meet the requirements in all particulars.

The limitations of weights made it necessary to design all the parts as light as possible, consistent with the proper strength. The built-up type of construction of plates and angles was freely used in the main frames and the tender frame bracing wherever it was found that such a construction could be satisfactorily employed. Care was taken to produce a symmetrical, clean looking design and wherever it was feasible the parts were made in one piece. For example, the guide yoke and the link supports were made in an integral casting, thus eliminating bolted connections and reducing the weight of the parts.

The limit for the dynamic augment at a speed of 50 klm. (37.3 miles) per hour was specified at 15 per cent of the static wheel load. In order to come within these requirements and at the same time provide the proper counterbalance, the reciprocating parts were made of very light design and a special method was employed to secure an exact adjustment of the counterweights in the driving wheels. The dynamic augment requirements were met and by means of careful adjustment the proper counterbalance was secured for the reciprocating weights.

The boiler is of the extended wagon top type, radially stayed and fitted with a combustion chamber. The locomotives are equipped with superheaters and the reversing mechanism is of the Lawson patented screw type, which provides for easy operation and is fitted with a positive locking device and an indicator which shows the exact cut-off at which the engine is operated.

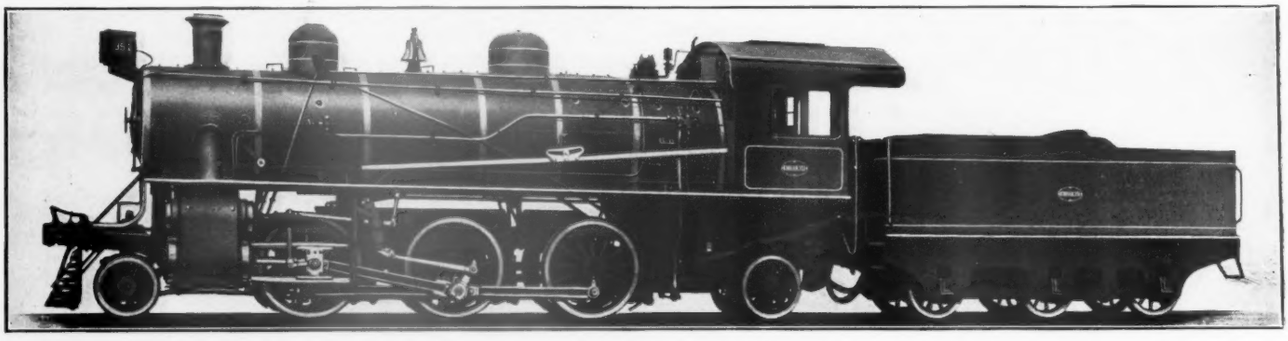
The tender is of the six-wheel, rigid wheel base type, with plate side frames, the journal boxes working in pedestals riveted to the outside plates of the frame. The two rear pairs of wheels under the tender are equalized. The tender tank is 20 ft. 8 in. long by 9 ft. 8 in. wide by 4 ft. 2 in. high inside, and is built up of ¼-in. steel plate reinforced with 2½-in. by 2½-in. by 5/16-in. angles. The coal space is 4 ft. 9 in. wide and is 6 ft. 2 in. long at the floor, extending back on the slope sheet for a distance of 5 ft., giving a coal capacity of 13,300 lb. The water capacity of the tender is 4,800 U. S. gallons.

Great care was necessary in making the tender design to meet the limitations of axle load as given in the specification. In general, the locomotive was designed along the lines of American practice and the builders were given a free hand in the construction of details so long as they were kept within the limitations of the specifications. The general dimensions of the locomotive, as well as the actual weights as compared with the weight limitations specified are given in the following table:

Engine	Actual weight	Limit of weight
Front drivers	32,600	33,000
Main drivers	32,600	33,000
Back drivers	32,000	33,000
Total drivers	97,200	99,000
Engine truck	28,400	28,500
Trailing truck	30,400	31,300
Engine, total	156,000	158,800
Tender		
Front wheel	30,400	30,800
Middle wheel	30,600	30,800
Back wheel	30,600	30,800
Total	91,600	92,400

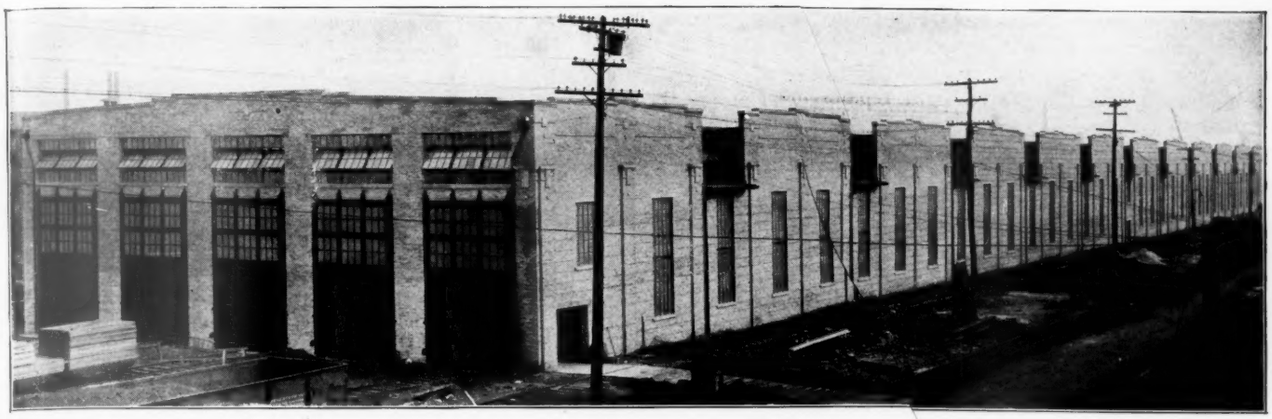
General Data

Gage	4 ft. 8½ in.
Service	Mixed
Fuel	Soft coal



Prairie Type Locomotive for Service in China

Tractive effort	25,500 lb.
Weight in working order	156,000 lb.
Weight on drivers	97,200 lb.
Weight of engine and tender	247,600 lb.
Wheel base, driving	13 ft. 10 in.
Wheel base, total engine	31 ft. 7 in.
Wheel base, total engine and tender	53 ft. 10 in.
Cylinders, diameter and stroke	20 in. by 26 in.
Valves	12 in. piston
Drivers, diameter over tires	59 in.
Driving journals, diameter and length	8½ in. by 11 in.
Boiler	Extended wagon top
Working pressure	170 lbs.
Outside diameter, first ring	61 1/16 in.
Firebox length and width	84 in. by 54½ in.
Tubes, number and diameter	130, 2 in.
Flues number and diameter	21, 5⅜ in.
Heating surface, tubes and flues	1,418 sq. ft.
Heating surface firebox including arch tubes	207 sq. ft.
Heating surface total	1,625 sq. ft.
Superheating surface	366 eq. ft.
Grate area	31.6 sq. ft.
Tender	
Type	Six wheel
Tank	U shape
Frame	Plate
Weight	91,600 lb.
Journals, diameter and length	5⅛ in. by 10¼ in.
Water capacity	4,800 U. S. gals.
Coal capacity	13,300 lbs.



A Longitudinal Type of Repair Shop.

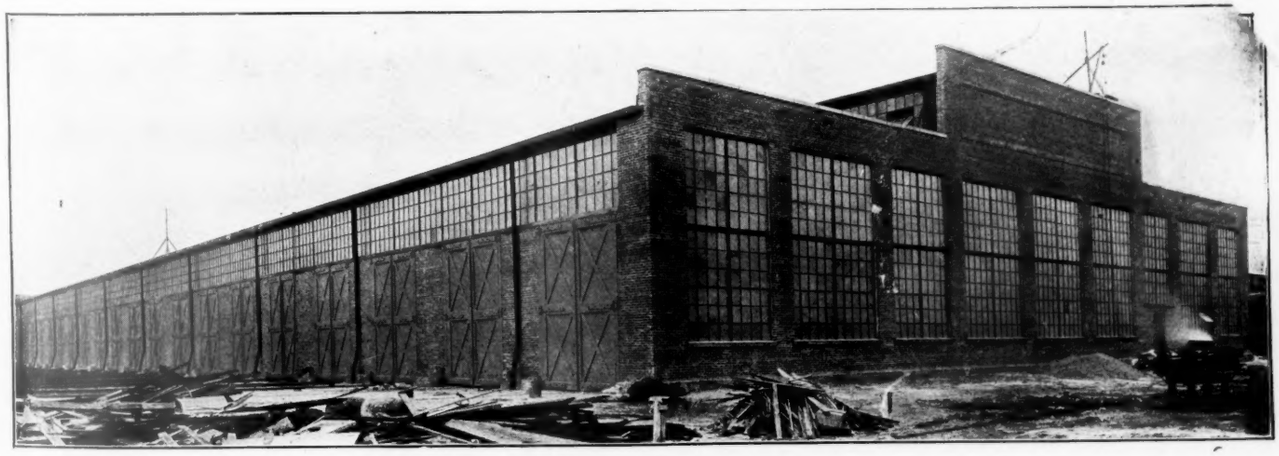
MODERNIZING FREIGHT CAR REPAIR FACILITIES*

A Presentation of the Several Phases of This Subject and a Proposed Shop and Yard Layout

BY GUSTAVE E. LEMMERICH
Layout Engineer, The Austin Company, Cleveland, Ohio

THE TREMENDOUS industrial growth of our country, its railroad traffic and its foreign commerce has created a need for a transportation machine which will not only meet these demands but also keep abreast of the times. It has been estimated that there is an urgent need for 700,000 new freight cars; but even if this is true, it will be practically impossible to obtain delivery of such a large number for several years, as there is at the present time an insufficient manufacturing capacity. The total existing freight car equipment consists roughly of about 2,500,000 cars. If facilities are provided for obtaining the maximum road service from these cars, quicker relief will be afforded perhaps than could be secured by waiting for the delivery of all the new cars needed. For instance, statistics recently compiled by competent operating officers show that the average car-miles per day on several important roads have varied from 25 to 37. Any improvements which will bring the low average nearer the high average of car-miles per day will produce more net revenue than the purchase of new cars. Undoubtedly, a combination of the two means of relief will be necessary to bring about the desired results.

In 1917 about twenty-nine million cars received light repairs and about two million cars received heavy repairs, i. e., practically every car was sent in for light repairs once a month, and about 80 per cent of the total equipment underwent heavy repairs once a year. For the past four years the average cost of these repairs has more than doubled. The weighted average cost of freight car repairs, computed from an article on "The Maintenance of Freight Equipment" by L. K. Sillcox, on page 657 of the November, 1919, issue of the *Railway Mechanical Engineer,* was about $79 per car in 1916 and $170 in 1918. These costs were based on about 500,000 cars. This increase was due in general to the high cost of materials and labor, the construction and condition of the cars, and the lack of proper facilities for making efficient repairs. It does not appear that the first item will change much for some time, but it is probable that labor costs will



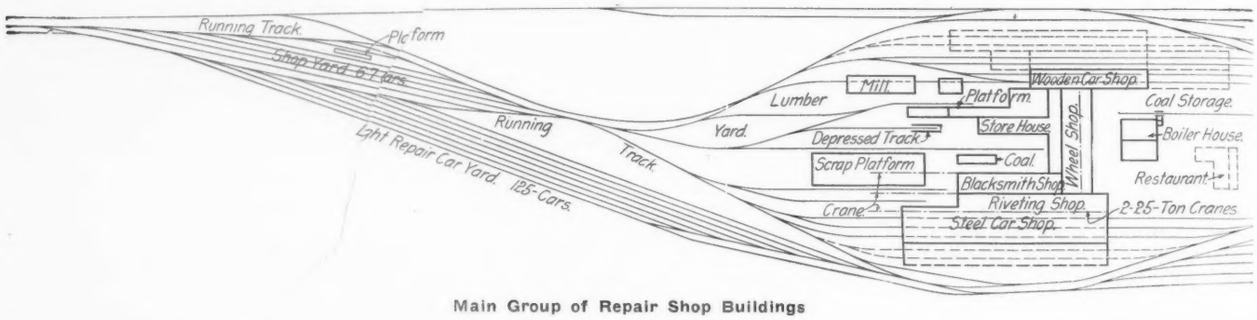
A Paint Shop of the Transverse Type

*Copyright by Gustave E. Lemmerich.

decrease, due largely to increased efficiency. This combination of high costs and ever-increasing traffic calls for prompt improvements in handling all car repairs, and particularly affording a means of making light repairs independent of weather conditions.

Making Needed Improvements

There is an apparent tendency toward better and stronger rolling stock, designed to withstand the heavy strains of long



Main Group of Repair Shop Buildings

train and yard operation. Old, weak equipment should be reinforced or assigned to a class of service in which it may still be useful, or it should be scrapped. All underframes in heavy freight service should be of steel.

It does not appear that the seriousness of the car situation lies so very much in the present needs for a large number of new cars as in the immediate demand for proper

Car Equipment.

(a) Modernizing old equipment. (b) Larger and stronger cars.

Car Repair Facilities.

(a) Better and more conveniently arranged shops, equipped with facilities for accelerating the return of the equipment to revenue service.

Traffic Improvements.

(1) *General.*

The continuation of the Railroad Administration Car Service Section, revised to suit the new conditions.

(2) *Reduce Time at Terminals.*

(a) The continuation of the present policy of unification of terminals. (b) The establishment of union freight stations in the larger cities. (c) A more universal application of modern loading and unloading devices.

Interior View of the Transverse Shop

facilities for repairing and modernizing the present equipment, and for the pushing of other improvements which will tend to better car movements at the terminals and on the line. Inasmuch as those facilities are so closely interwoven with the freight car situation, an outline of some of the important suggestions, which will tend to improve the car situation, may not be amiss:

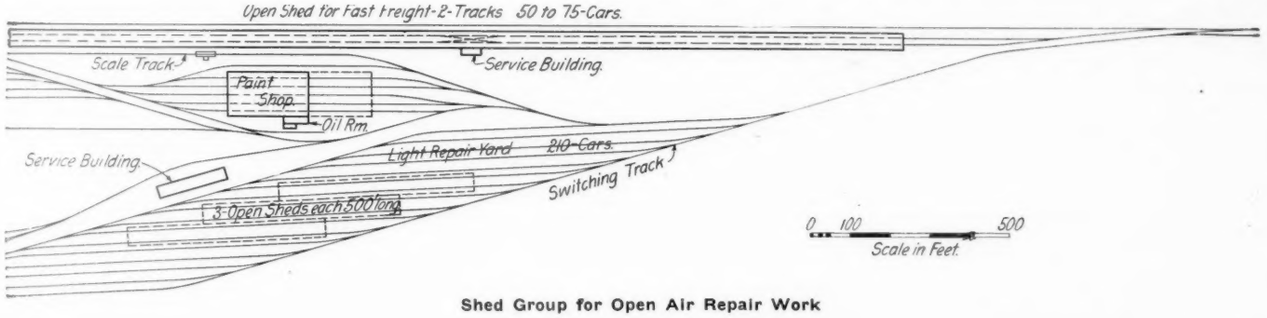
(d) Improvements of terminals, varying from some minor betterments costing only a few thousand dollars, to vast projects, such as detour lines around the great congested traffic centers.

(3) *On Line.*

Other improvements, such as additional tracks, automatic block signaling, etc.

(b) Important changes resulting from the consolidation of railroads, creating new steam traffic lines.

All of these improvements would greatly facilitate car movements, and they would result in returning cars much quicker, so as to increase their earning capacity. For example, if these additional betterments would result in only a 10 per cent earlier return, it would mean at least a reduction of about 8 per cent in the number of cars needed to relieve the present shortage.



Shed Group for Open Air Repair Work

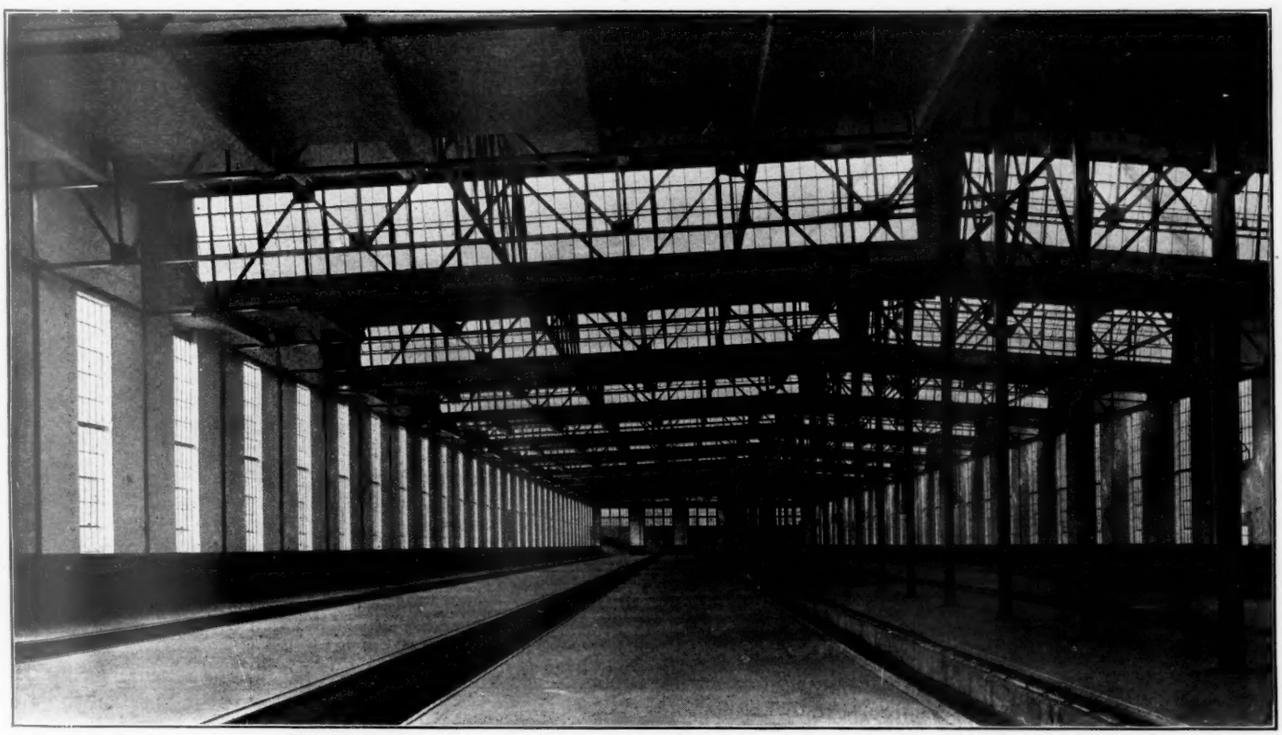
A tentative estimate of the new freight cars required in the next three years calls for about 700,000, or about 230,000 cars per year. Eight per cent of the yearly requirements would be about 18,000 cars. At an average cost of $2,850 per car, this is equivalent to a total cost of $51,300,000. Capitalizing this sum at 10 per cent for interest, depreciation, etc., will provide a fund of $513,000,000 available for these improvements. This sum would go a long way toward paying for most of the improvements suggested.

General Freight Car Repair Shop Requirements

The question of the location of car repair shops is chiefly dependent on the dominating traffic characteristics and on the prevailing local conditions of the particular railroad considered, its size, the empty car movements, the available and suitable site, the labor conditions and the material market, etc. In former years, when the mills and the lumber yards were of greater importance in freight car repairing, the main car shops were, in many instances, located at the general repair shop plant of the system, only a few railroads selecting separate locations. The freight car repair shop organization is so different in its character and functions that there is no advantage in having it at the general repair site, except that both should possess all the particularly favorable points affecting construction and operation.

On the larger railroads the traffic conditions are often so greatly divergent in character that, in order to save empty car mileage and to return the cars quicker to their earning power, it might be advantageous to divide the car repairing between district shops. This division could be extended to provide separate repair shops for steel cars and for wooden cars, each located at the most suitable place.

The layout should embody the principle of a continuous mill operation, the materials entering as much as possible at one end, and the building and organizations so grouped as to avoid any conflicting movements. Such an arrangement is indicated in the tentative layout accompanying this



Interior of the Longitudinal Type Shop

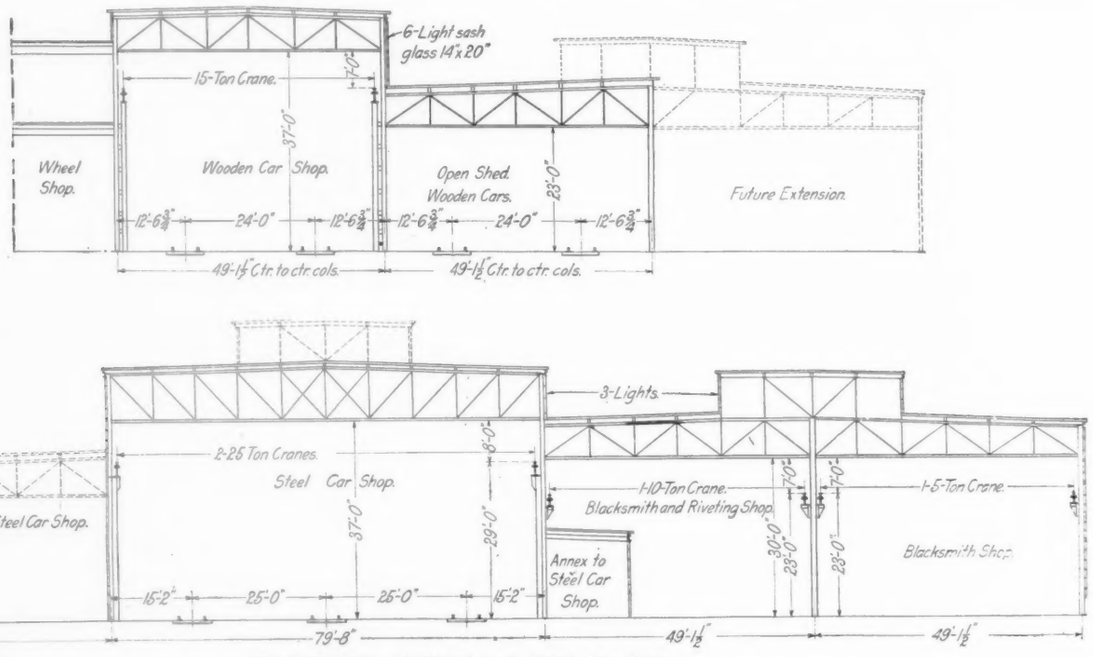
article. The principal buildings should be all under one roof, effecting a saving of a large amount of unnecessary travel and adding greatly to the efficiency of operation.

All buildings should be commensurate to the purpose they have to serve, i. e., they should be of a substantial character, void of all fads, but equipped with all modern facilities. Inasmuch as these structures require large areas, standard dimensions should be adopted wherever possible to reduce the cost and to shorten the time of construction. Such standards should cover the width of the buildings, the vertical clearances, and the column spacing, etc., due consideration being given to the local and operating requirements. The track centers should be such as to give a good workable aisle width, a feature which is of special importance in steel car shops on account of the space needed for the riveting furnaces. This applies to the tracks besides the building walls, as well as to the interior aisles. The buildings should be well lighted, heated and ventilated, and should be provided with cranes wherever they will result in better and more efficient operation.

In former years the wood mill was one of the pivotal features in the layout, but now that wooden underframes are practically a thing of the past, so far as new work is concerned, this department has lost its importance, and a comparatively small building with a few tools is all that is required. The mill, however, should have as an auxiliary a finished lumber shed. The lumber yard has also shrunk to comparatively small proportions.

Auxiliary Building and Equipment

The storehouse with its platforms should be located centrally and conveniently. The building should be of reinforced concrete, provided with a full equipment of bins, an office, etc. The scrap platform in a freight car repair plant is of great importance and should be readily accessible for the delivery of scrap and for the forwarding of it to the blacksmith shop. This platform should also have facilities for the handling, cutting, sorting and storing of all grades of scrap, and a shed for housing some of these should be provided. The other auxiliaries to the storehouse should



Cross Section of Wood and Steel Car Shops

In general, car repair shops are located in or near large freight yards and, in most cases, on filled ground. These conditions, together with the fact that car repair plants are frequently built outside of cities, render it advisable to make the buildings of steel frame construction with walls practically entirely of glass. Where the application of glass is not desirable, such as at the corners and below the windows, asbestos-covered corrugated metal or some other permanent wall substitute should be used. The use of brick should be limited as much as possible or eliminated entirely in order to simplify the construction. The roof can be built with wooden purlins and 2-in. dressed and matched roof boards, the under side being whitewashed to serve as a fire retardant.

A dirt floor appears to be all that is needed in the buildings used for the steel car departments; this can also be used for the wooden car shops in order to reduce the initial cost. If, later, it should be found desirable to have a floor in the wood car shop, old car sills can be used advantageously. In the mill, the wheel shop, and the tool room, the use of creosoted wood blocks laid on a concrete base will be found to be satisfactory, while concrete floors are most frequently used in the storehouse, locker and toilet rooms.

include storage places for wheels, steel plates, angles, beams, castings, etc., and coal, coke and iron sheds for the blacksmith shop. The ground for these storages should be, above all, dry and well rammed with slag.

If this plant is isolated, it will require a fully-equipped power house. If, however, the plant is attached to or near an engine terminal or some other shop layout, the need for a power house is entirely dependent on the respective local conditions. A very important piece of equipment, usually installed in the power house, is the air compressor, which is generally of too low a capacity to meet the present increasing demands. The main shop buildings should have provisions for offices, lockers, wash rooms, toilets, etc., and other plant requirements, such as drainage and sewer system, a water supply and fire protection system, a lighting system, an air piping system, telephone and telegraph connections, if desirable, and finally the necessary yard tracks, etc.

Equipment and Tools

The shop should be fully equipped with modern tools and machines to do the work for which the plant is intended. The power equipment should be on liberal lines, especially

the air compressors. In specifying them, it should be considered that some light repairing may have to be done outside of the regular working hours.

Crane service should be provided wherever it will be economical, and the use of cranes should be extended outside of the building in order to facilitate the handling of material from the yard and to serve in repairing cars during that period of the year when the work can be done on the outside. Such an application will decrease the amount of the fixed charges per car repaired, resulting from the cost of the complete shop plant. The cranes in the steel car shop should have a capacity of 25 tons. In any important layout two should be installed which, when working together, can manage a 150-ton capacity car. In the wooden car department, cranes of 15 tons' capacity will be sufficient. The installation of cranes in the auxiliary departments depends, of course, entirely on their importance. A large locomotive crane is generally a good paying investment, because it combines the handling of material and the switching of cars in one unit. Of late a powerful tractor has been found to be a useful piece of equipment for transporting all classes of material about railroad shops and yards.

This article is confined to a repair shop with some rebuilding, so that the repairing functions, being in preponderance, govern the character of the layout, organization and equipment. The great importance to some roads of having most of its car equipment provided with steel underframes might make it advisable to enlarge the repair shop riveting department, so that some or all of the new steel underframe work of the system could be undertaken. Such an arrangement might stabilize the work and organization of this shop, and will only require a somewhat longer building and few additional tools. Local conditions might make it desirable to have a restaurant, reading rooms, etc., connected with this plant. These could be located in a service building back of the power house. Part of the ground surrounding this building could be treated in some pleasing way for recreation, etc.

A plant serving a district was selected for the tentative layout because shops of this type are particularly suited to meet the present needs; moreover, they conform better to economical freight car operation because their location would result in a minimum empty car movement, yet they are large enough for economical operation.

The Tentative Layout

The plan represents a repair shop with a capacity of about 9,000 cars per year, and provides separate shops for wooden and steel cars, connected by a wheel shop with a crane that will transfer the material between the two shops. It is assumed that this plant is located in a terminal, with its entrance, the yards for the shop and the light repair work directly behind the criple tracks near the hump on the main traffic yard, or beside one which would be a starting point for the majority of empty car movements.

Of course, this layout must be arranged to conform with the existing local or other traffic conditions, but it must still retain certain vital principles. These include a departmental plan of the yard and buildings, so that the movements of the material are such that the entire plant is on the continuous mill principle, and an interchangeability of the two yards for both the shop and the light repair yard. The buildings for fabricating the materials used in car repairs, such as the mill with its lumber shed, the blacksmith shop, the storehouse, etc., are entered first in the operating plan. With the exception of the mill, the power house and the paint shop, all buildings are under one roof, and this, taken in connection with the crane service, as outlined later, should greatly facilitate the car repairing.

The wooden car shop proper is 50 ft. wide by 300 ft. long, with a capacity of 32 cars, assuming 50 ft. as the length required per car when undergoing repairs, and contains two tracks and one 15-ton crane. The crane runway extends outside of the building, bringing 8 cars under crane service. Adjoining this shop is a covered shed holding 12 cars. The steel car shop is 80 ft. by 520 ft. in area, and contains three tracks, holding a total of 27 cars, which are served by two 25-ton cranes. One track is cut to permit the placing of a large furnace and some tools in the bay, so formed in order that the crane can carry large sections of damaged steel to the furnace, to the tools and back to the car proper.

In the car shops the distance from the top of the rails to the under side of the trusses is fixed at 37 ft., and to the top of the crane rail 29 ft. and 30 ft., respectively, for the steel car shop and the wooden car shop. This height will permit the handling of side plates, etc., of steel cars of considerably higher and greater capacity than are now in use.

The blacksmith shop is located in two aisles, one adjoining the steel car shop at the furnace section, so as to bring it into the blacksmith shop organization. The riveting shop adjoins the steel car shop, but is at the finished car end of the building; its width also being 50 ft., with its length dependent on the amount of new steel underframe work assigned to it. Both of these auxiliary shops are equipped with cranes. The wheel shop proper is 50 ft. wide by 260 ft. long, with two side aisles, each 30 ft. wide, one containing the tool room, which is back of the storeroom and directly connected to it; the offices and some minor machine tools, etc., while the other aisle contains the fan rooms, lockers, wash rooms and toilets.

The paint shop is situated beyond the other shop buildings and is a well-lighted building, with posts between each track, with dirt floors, and with pits under two of the tracks. The size of this building is assumed to be about 100 ft. wide by 200 ft. long, with a fireproof oil storage room in the form of an addition to it. In case it should be preferred to paint some parts or all of the steel cars in the steel car shop, the paint shop could be greatly reduced or omitted entirely for the time being.

At the farthest end of this layout there are a few yard tracks to accommodate the cars from the other hump.

An approximate estimate of the cost of the freight car repair shop, as indicated in this layout, is as follows:

	Cost		Per cent of total
GRADING AND TRACK			
Grading and drainage	$44,000		3.5
Track	91,000		7.5
Total		$135,000	11.0
BUILDINGS			
Wood car shop, covered shed and crane run way	$65,000		5.5
Mill and finished lumber shed	24,000		2.0
Wheel shop, tool room, etc.	68,000		6.0
Steel car shop, blacksmith and riveting shops, crane runways	220,000		18.5
Storehouse platform, scrap platform, etc.	40,000		3.0
Paint shop	35,000		3.0
Power house, including coal and ash handling, stack, etc.	72,000		6.0
Miscellaneous—Water supply, fire protection, sewerage, plumbing, walks, etc.	36,000		3.0
Total		560,000	47.0
EQUIPMENT			
Tools	$165,000		14.0
Power house	115,000		9.5
Cranes	105,000		8.5
Total		385,000	32.0
MISCELLANEOUS			
Cost of land, interest during construction, engineering and contingencies		120,000	10.0
Grand total		$1,200,000	100.0

The fixed charges on $1,200,000 at 12 per cent per year would amount to $144,000.

These improvements should result in a reduction in the cost of repairing per car, and in a reduction in the time consumed in having these repairs performed. Assuming a 10 per cent saving in the repair account which, at an average

cost of $170 per car, would amount to $17, or, on 9,000 cars per year, would amount to $153,000, or more than enough to finance the improvements. In addition, the time saved by a plant of this kind in returning cars to their earning power more promptly, also represents a money saving which can be used for financing other improvements.

The Light Repair Yard

There appears to be a tendency in the development of light repair yards to cover a part of the tracks to protect the repairmen against inclement weather. If this is applied along reasonable lines, it will promote more efficient and quicker car repairing, and, at the present rate of wages, will also prove to be a paying investment. If this should run to the extreme, however, it might result in an entirely different type of layout for the light repair yard. Perhaps it might tend to enlarge the sphere of the repair plant and make it necessary to provide a series of open sheds beside the repair shop buildings.

In this layout the light repair yard consists of 14 tracks of 15 cars each, arranged in pairs on 22 ft. and 28 ft. centers, thus permitting an open shed, when so desired, for the storing of material, pipe lines, etc., which could be about 500 ft. long and cover 20 cars each. The material storage shop, a storeroom, an office and the locker, wash and toilet facilities, are located at the ladder track toward the main shops. The switching is done from the ladder on the other side of the yard, so that this ladder is only used in emergencies. The size of these facilities is dependent on their importance and the local conditions prevailing at the terminal. An approximate estimate, which includes three open sheds, each 500 ft. long, theoretically covering 60 but practically 75 cars, is as follows:

	Cost		Per cent of total
Grading and drainage	$40,000		
Track	85,000		
Total		$125,000	53.0
Service building, including plumbing	$15,000		
Equipment, fire protection, etc.	15,000		
Total		30,000	13.0
Three covered sheds, 500 feet long		45,000	19.0
Miscellaneous—Cost of land, interest during construction and contingencies		35,000	15.0
Grand total		$235,000	100.0

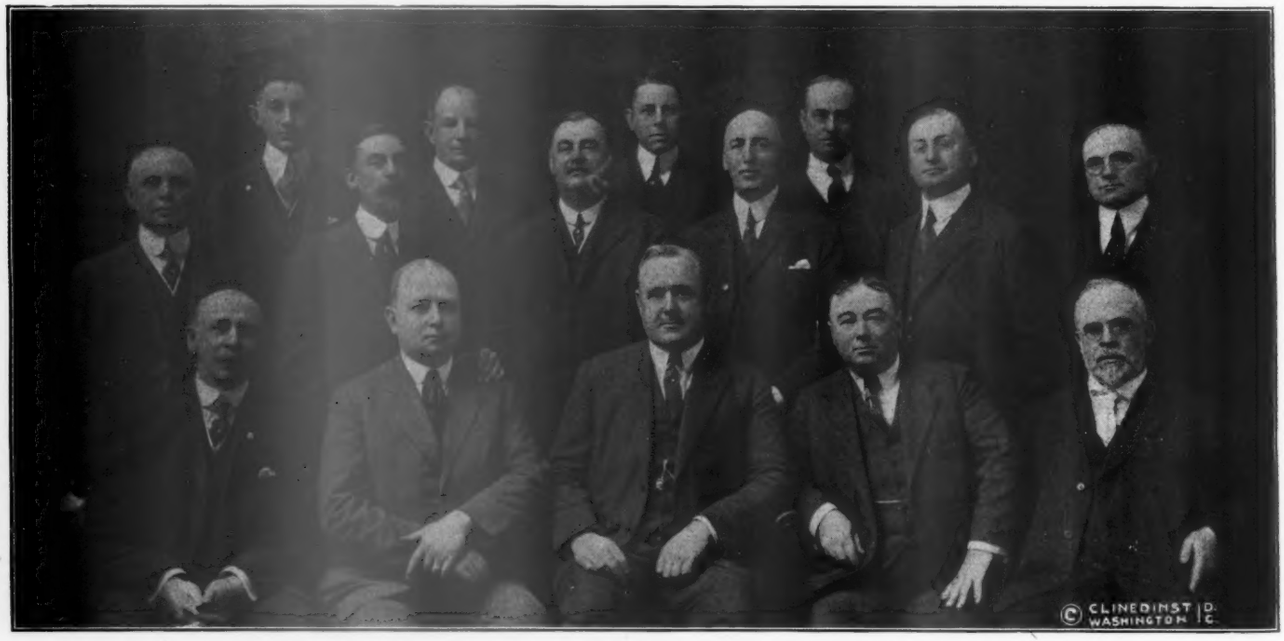
Fixed charges on this investment at 12 per cent equals $28,200 on 80,000 cars a year, which is the average number such a yard should handle, and it will result in a cost of about 35 cents per car receiving light repairs. The open shed represents about 19 per cent of the total cost.

An Open Shed for Through Freight

The tentative layout also indicates an arrangement for an open shed for fast through freight trains, which will tend to facilitate inspection, the testing of air and some very light repairing under all weather conditions, thus decreasing the chances for delays at the terminals. However, local conditions might make it advisable to place these sheds at some other point. The layout is for two tracks, each holding 56 cars 42 ft. long. A diamond cross-over at about the middle of this shed permits a single track operation when required, and about two 22-car sections may be set for very light repairing. For this layout the size of the shed was assumed to be about 40 ft. by 2,260 ft., with posts set 22 ft. apart on center. The construction is of wood, and the shed should be provided with air pipes and a small shelter in the center for an office, a few tools and the toilets, etc. An approximate estimate of the cost is as follows:

Open shed and small service building annex	$56,000
Air piping, few tools and diamond cross-over	5,000
Miscellaneous	4,000
Total	$65,000

The fixed charges at 14 per cent per year would amount to $9,100. Assuming this shed will be used by 100,000 cars per year, the fixed charges per car will be 9 cents.



Committee on Standards for Locomotives and Cars, United States Railroad Administration

First Row—Seated (Left to Right): J. J. Tatum, general supervisor of car repairs, U. S. R. A.; F. P. Pfahler, chief mechanical engineer, U. S. R. A.; **Frank McManamy,** assistant director, division of operation, U. S. R. A.; and chairman of the committee; John Purcell, assistant to federal manager, **Atchison,** Topeka & Santa Fe; A. W. Gibbs, chief mechanical engineer, Pennsylvania Railroad, Middle Row—Standing (Left to Right): **C. E. Fuller, superintendent** motive power and machinery, Union Pacific; **F. F. Gaines,** Board of Railroad Wages and Working Conditions, U. S. R. A.; **W. H. Wilson,** assistant to federal manager, Northern Pacific; **H. T. Bentley,** superintendent motive power and machinery, Chicago & North Western; **J. E. O'Brien,** superintendent motive power, Missouri Pacific; **J. T. Carroll,** general superintendent, maintenance of equipment, Baltimore & Ohio. **Top Row —Standing (Left to Right):** H. Zalkind, stenographer; **J. W. Small,** mechanical assistant to regional director, Southern Region, U. S. R. A.; E. A. Woodworth, secretary; H. Ingersoll, mechanical assistant to regional director, Eastern region, U. S. R. A.

THE INSPECTION OF FREIGHT EQUIPMENT

Defects of Couplers and Related Parts; Federal Requirements for Safety Appliances Summarized

BY L. K. SILLCOX

Master Car Builder, Chicago, Milwaukee and St. Paul

COUPLERS must be in good condition as regards wear and operation of parts, and should be within the minimum and maximum heights as provided by the rules of interchange. Couplers that exceed the distance of 5⅛ in. between the point of the knuckle and the guard arm, measured perpendicularly to the guard arm, must have the defective part or parts renewed to bring the coupler within the limits of the gage.

Couplers measuring less than 9¼ in. from the inside face of the knuckle to the striking face of the coupler horn should not be applied in repairing foreign cars. This should not be construed to mean that a coupler with 9¼ in. dimensions may be substituted for the MCB temporary standard type *D* or 6 in. by 8 in. shank coupler. It is necessary to stencil cars equipped with the *D* type of coupler in order to protect them against substitution of the present type with 5 in. by 7 in. shank.

Height of Couplers

Empty cars measuring 32½ in. or less from the top of the rail to the center of the coupler shall be adjusted to 34½ in. or as near as practicable thereto, but not exceeding 34½ in. Loaded cars measuring 31½ in. or less shall be adjusted to 33½ in. or as near as practicable thereto, but not exceeding 33½ in. When the construction of the car and the trucks precludes the common methods of adjusting coupler heights, such as raising the truck center plate height locally on top of the truck bolster, or placing fillers on top of or below the spring seats, the application of metal shims between the journal boxes and arch bars will be permissible. The use of liners between the male and female portions of center plates is prohibited where the vertical bearing surfaces are reduced by the insertion of such liners.

Couplers which are not within the limits of 31½ in. to 34½ in. from the rail not only constitute defects according to the rules of interchange but are also in violation of the requirements of the Safety Appliance Act.

Normal Clearance for Freight Car Couplers at Top and Side of Shank

In fitting up couplers in freight equipment cars it should be arranged to have 1¼ in. clearance on each side, that is, between the outside face of the shank and the inside face of the draft sill. The clearance between the top of the shank and the under side of the opening in the end sill is to be 3/4 in.

Cotter Keys in Knuckle Pins

Cotter keys are not to be applied to knuckle pins and couplers on cars other than hopper and fixed end gondolas.

Uncoupling Lever Connections Short

One of the very serious and easily avoidable items to be considered by inspectors is any lack of clearance causing restricted movement of the uncoupling connections so that when couplers take the full amount of slack possible the lock is lifted causing break-in-twos. This is often due to parts of the uncoupling mechanism becoming distorted and bent.

Third of a series of articles on this subject by Mr. Sillcox. Copyright by the Simmons-Boardman Publishing Company.

Coupler Yokes or Tail Straps

Coupler yokes are to be gibbed wherever possible to neatly fit the end of the draw bar butt and thus relieve the rivets of as much shearing stress as possible.

Coupler Yoke Rivets

The standard of practice for new car equipment and new couplers is to use 1¼ in. diameter yoke rivets. However, there are a number of couplers now fitted with 1⅛ in. diameter rivets requiring repairs at shops where these couplers can be reamed out to take the standard size, and this should be done. At shops where there are no facilities for changing couplers to take the larger sized rivet, it will be admissible to apply the smaller size. Also, when foreign cars appear on repair tracks which are fitted with 1⅛ in. diameter rivets, the same size can be reapplied.

Coupler yoke rivets should be headed on opposite sides; that is, one rivet will be headed on one side of the yoke and the other rivet will be headed on the opposite side of the yoke.

Coupler Carry Irons

All coupler carry irons must be held in place by at least four bolts if placed vertically and one through bolt with the necessary casting if placed laterally, all securely fastened in place. On wooden draft timber system cars, coupler carriers are to be gibbed or turned up on the ends to avoid the draft sills splitting or breaking away.

Safety Appliances

All safety appliances should be closely inspected and known to be in proper condition, and if not, prompt and proper repairs should be made, remembering especially that couplers must not measure more than 34½ in. from the top of the rail to the center line of the head or less than 31½ in. when the car is empty. Any defects or combination of defects which would cause a coupler to be inoperative, hand brakes, hand-hold, sill steps or other parts to be found covcovered in the rules relating to the inspection of safety appliances must be carefully considered. Passenger train cars used in freight or mixed service must be fitted with uncoupling attachments operative from the left hand side of the car to conform with the rules for freight cars.

Cars, whether loaded or empty, having safety appliance defects must have such defects repaired immediately upon discovery and will not be offered in interchange. If it is necessary to move the car to the shops for repairs of safety appliance defects, it must be moved to the shops of the company upon whose line it became defective.

Equipping Cars with Safety Appliances

Close attention is essential in the matter of giving proper attention in the equipping of cars with safety appliances, both foreign and system. Whenever system cars are loaded and it is found they are not equipped with safety appliances, if routed to some foreign railroad, the routing and destination must be ascertained so that the matter can be taken up with the foreign railroad to have them equip our cars. We must also equip foreign cars on our road, rendering a bill against the owners for the expense of doing the work.

Hand Brakes

Each car shall be equipped with an efficient hand brake, which shall operate in harmony with the power brake thereon. The hand brake may be of any efficient design, but must provide the same degree of safety as the design shown on Plate A of the Safety Appliance Standards.

Brake Shaft

The brake shaft shall be made of wrought iron or steel not less than 1¼ in. in diameter, without weld, and provided with a drum and trunnion. The drum shall not be less than 1½ in. in diameter and the trunnion not less than ¾ in. in diameter. The shaft is to be held in position with a cotter key or ring. The upper end of the shaft is to be arranged to hold the brake wheel with a square fit, not less than ⅞ in. and of a nominal taper 2 in. in 12 in. and is to be threaded to such an extent as to provide for not less than a ¾ in. nut. The end of the shaft shall be riveted over or held in position by a lock nut or suitable cotter to secure the nut.

Brake Chain

The brake chain shall be made of wrought iron or steel, not less than ⅜ in. in diameter with a rod link of not less than 7/16 in. and is to be secured to the brake shaft drum by a hexagon or square head bolt, not less than ½ in., the nut of which must be securely riveted over.

Brake Shaft Seat or Step

The brake shaft seat or step shall be held in position by a stirrup of such design that it will not permit the brake chain to drop under the shaft, U-shape preferred.

Brake Step or Foot Board

If a brake step (foot board) is used, it shall be 28 in. in length. The proper clearances for this brake shaft must be provided so that the outside edge shall be not less than 8 in. from the face of the car and not less than 4 in. from a vertical plane parallel with the end of the car, the 4 in. measurement to be taken from a line passing through the inside face of the knuckle, when closed, with the coupler horn against the buffer block or end sill. The brake step is to be supported by not less than two metal braces, having a minimum cross-sectional area of ⅜ in. by 1½ in. or equivalent securely fastened to the body of the car with not less than ½ in. bolts or rivets.

Brake Ratchet Wheel

The brake ratchet wheel must be not less than 5¼ in. in diameter, with not less than 14 teeth, and is to be secured to the brake shaft by a key or square fit. If secured by a square fit, it shall be not less than 1 5/16 in. square. Provision must be made to prevent the ratchet wheel from rising on the shaft and disengaging the brake pawl.

Brake Shaft Support

When the brake ratchet is more than 36 in. from brake wheel an extra support must be provided to support the extended upper portion of the brake shaft and the extra supports shall be fastened by not less than ½ in. bolts or rivets.

Brake Pawl

The brake pawl shall be pivoted upon a bolt or rivet not less than ⅝ in. in diameter, or upon a trunnion. If the pawl is placed upon a trunnion, the pawl is to be secured by a bolt or rivet not less than ½ in. The brake pawl and brake shaft are to be connected by a rigid metal connection.

Brake Wheel

The brake wheel shall be made of malleable iron, wrought iron or steel, and may be flat or dished, not less than 15 in. in diameter, and is to be fastened to the brake shaft with a square fit in the hub; the taper to be nominally 2 in. in 12 in. The proper clearance provides for not less than 4 in. around the rim of the wheel and other clearances specified call for not less than 4 in. from a vertical plane drawn parallel with the end of the car and passing through the inside face of the knuckle, the coupler and knuckle to be in closed position with the coupler horn against the buffer block or end sill when this measurement is taken.

Location of Brake Shaft

Box and Other House Cars.—On the end of the car, to the left of and not less than 17 in., nor more than 22 in. from the center.

Hopper Cars, High Side Gondolas with Fixed Ends, Low Side Gondolas with Fixed Ends and Low Side Hopper Cars.—To the left of and not more than 22 in. from the center.

Drop End Low Side Gondolas, Drop End High Side Gondolas, All Tank Cars, Caboose Cars Without Platforms.—On the end of the car to the left of and not more than 22 in. from the center.

Flat Cars.—On the end of the car to the left of the center, or on the side of the car not more than 36 in. from the right hand end thereof.

Caboose Cars with Platforms.—On the platform to the left of the center.

Uncoupling Levers or Lift Bars

Uncoupling levers shall be made of any efficient design and may be single or double, without weld. They are to be located one on each end of the car. When a single lever is used, it shall be placed on the left side of the end of the car. Uncoupling levers shall not be more than 12 in. from the side of the car. Center lift arms to be not less than 7 in. long. The center of the eye at the end of the center lift arm shall extend not more than 3½ in. beyond the center of the eye of the uncoupling pin in the coupler when the coupler is against the buffer block or end sill. The handles of uncoupling levers shall extend below the bottom of the end sill not less than 4 in. If the handles are not constructed so as to provide for this, the minimum clearance which must be provided is 2 in. around the handle. The minimum drop for uncoupling levers shall be 12 in. and the maximum 15 in. The distance from the rail to the handle of rocking or push down type levers shall be not less than 18 in. from the top of the rail when the lock block has released the knuckle. Provision shall be made to prevent the inside arm from flying up in case of breakage by having a suitable stop provided. All uncoupling levers for the different classes of cars are of the same kind and dimensions, except those for tank cars without end sills. On these cars the minimum length shall be 42 in. measured from the center line of the end of the car to the handle of the lever.

Sill Steps

Four sill steps shall be provided of wrought iron or steel, without weld. The minimum cross sectional area must be ½ in. by 1½ in. or equivalent, with a minimum clear depth of not less than 8 in. and tread not less than 10 in. If the steps exceed 21 in. in depth, they must be provided with an additional tread. Sill steps are to be fastened with not less than ½ in. bolts with the nuts outside (where possible) and riveted over, or not less than ½ in. rivets. Sill steps are to be located one near each end on each side of the car, not more than 18 in. from the end of the car to the center of the tread of the sill step. The outside edge of the tread shall be not more than 4 in. inside of the face of the side of the car and the tread not more than 24 in. from the top of the rail.

The foregoing rules in regard to sill steps apply to all classes of cars except tank cars without side sills and tank cars with short side sills and end platforms. On such cars one step must be located near each end on each side under the side hand holds.

There are other classes of cars not covered by the above instructions, namely, tank cars without end sills, where the sill steps are to be located one near each end of each side flush with the outside edge of the running board, as near the end of the car as practicable. If these steps exceed 18 in. in depth, they shall be made with an additional tread and be laterally braced.

Two side door steps must be provided on caboose cars without platforms, the minimum length being 5 ft. and the minimum width 6 in., minimum thickness of tread 1½ in.; minimum height of back stop 3 in. and the maximum height from the top of the rail to the top of the tread 24 in. The steps must be located one under each side door and shall be applied and supported by two iron brackets having a minimum cross-sectional area ⅞ in. by 3 in. or equivalent, each of which shall be securely fastened to the car by not less than two ¾ in. bolts.

Caboose Platform Steps

Caboose platform steps of safe and suitable box design shall be located at each corner of all caboose cars with platforms. The lower tread of the step shall be not more than 24 in. above the top of the rail.

Ladders

Ladders are to be made of iron, steel or wood, not less than ⅝ in. diameter if of wrought iron or steel. Wooden treads are to be not less than 1½ in. by 2 in. of hard wood. Ladder treads may act as hand holds. Ladders and treads must be secured by not less than ½ in. bolts with the nut outside (where possible), riveted over, or with ½ in. rivets. If wooden treads are gained into stiles, ⅜ in. bolts may be used. The proper clear length of treads is not less than 16 in. on sides of cars and 14 in. on ends of cars. There are exceptions in the case of tank cars without side sills and tank cars with short side sills and end platforms. Ladder treads on such cars shall be not less than 10 in. and shall have not less than 2 in. clearance. When ladders are not equipped with stiles, or with stiles extending less than 2 in. from the face of the car, they shall be equipped so that the bottom tread on the inside end is fitted with foot guards not less than 2 in. high. Ladder treads shall be spaced not more than 19 in. apart. A variation of 2 in. is allowed from the top tread to the bottom tread of the side ladder. The distance allowed from the top tread of the sill step to the bottom tread of side ladders is not more than 21 in. on box and other house cars, the top treads of ladders to be arranged not less than 12 in. or more than 18 in. from the roof at the eaves. The top treads of ladders on coal cars are to be arranged so that they are not more than 4 in. from the top of the car. End ladders are to be spaced to coincide with the treads of side ladders, 2 in. variation being allowed. When the construction of the car will not permit the application of the tread of the end ladder to coincide with the bottom tread of the side ladder, the bottom tread of the end ladder must coincide with the second tread from the bottom of the side ladder. Ladders on different classes of cars shall be located as follows:

Box and Other House Cars, Hopper Cars, High Side Gondolas with Fixed Ends.—Not more than 8 in. from the right hand end of the face of the car, or not more than 8 in. from the left hand side of the end of the car.

Drop End High Side Gondolas.—Side ladders must be located the same as on box and other house cars (no end ladders being required).

Two ladders are necessary on tank cars without side sills and tank cars with short side sills and end platforms, when such cars have continuous running boards and four ladders on cars having side running boards, if so located as to make ladders necessary. Two ladders on cars with continuous running boards are to be located, one at the right hand end of each side. Ladders on cars with side running boards are to be located one at each end of each running board. One ladder at each end is required on caboose cars with platforms, but the dimensions are not specified. Four ladders are required on caboose cars without platforms, the same as box and other house cars.

The variation allowable in the location for ladders on caboose cars without platforms is as follows: If the caboose has side doors, side ladders shall be located not more than 8 in. from the doors.

The following classes of cars do not require ladders: fixed end low side gondolas, drop end low side gondolas, flat cars, tank cars with side platforms and tank cars without end sills (if these tank cars have high running boards, making ladders necessary, the sill steps must meet ladder requirements).

CONFERENCE RULINGS.

Automobile Cars with Swinging End Doors.—These cars may come under the head of cars of special construction, and the end ladders may be placed as nearly as possible to the designated location.

Ladders.—Spacing of Ladder Treads. The spacing of top ladder treads shall be taken from the eave of the roof at the side of the car, whether a latitudinal running board is used or not.

Ladders and handholes need not be applied to swinging side doors of gondola and ballast cars. Ladders shall be placed on such cars as prescribed for high-side gondola and hopper cars, with the sill step under the ladder, or as near under the ladder as the car construction will permit. The ends and sides of cars are to be equipped with handholds in the same manner as flat cars.

Horizontal End Handholds

Handholds shall be made not less than ⅝ in. in diameter from wrought iron or steel, without weld. The proper clear length is not less than 16 in., but there are exceptions where it is impossible to use 16 in., and 14 in. may be used. The proper clearance is not less than 2 in. Eight handholds or more are required on certain classes of cars (four on each end) and four on other classes (two on each end).

The following classes of cars require eight horizontal end hand holds: Box and other house cars, hopper cars, high side gondolas with fixed ends, low side gondolas with fixed ends and low side hopper cars.

These end hand holds on the above named classes of cars are to be located four on each end, two of which must be not less than 24 in. or more than 30 in. above the center line of the coupler, where the car permits, except where the ladder tread acts as a hand hold.

There are cars so constructed as not to permit location of hand holds as above specified, namely, some fixed end and drop end low side gondolas and low side hopper cars; these hand holds are to be placed not more than eight inches from the side of the car. The other four end hand holds are to be located on the face of the end sills, not more than 16 in. from the side of the car, projecting outward or downward.

Upon the following classes of cars there can be but four horizontal end hand holds, namely, drop end high side gondolas, drop end low side gondolas, flat cars, tank cars with side platforms, tank cars without side sills, tank cars with short side sills and end platforms, and caboose cars with platforms. The other classes of cars equipped with but four horizontal end hand holds are tank cars without end

sills. The hand holds on these cars shall be located on the running board, one near each side on each end of the car, or on the end of the tank not more than 30 in. above the center line of the coupler, not more than 2 in. back of the edge of the running board. If located on the running board these handholds must project outward or downward.

The horizontal end hand holds shall be located on caboose cars with platforms as follows: One near each side on each end of the car on the face of the platform end sill. The clearance of the outer end of the hand hold shall be not more than 16 in. from the end of the platform end sill. An additional horizontal end hand hold is to be provided for cars with platform end sills 6 in. or more in width, measured from the end post or siding and extending entirely across the end of the car. The proper length of these additional end hand holds is not less than 24 in., and they must be located near the center of the car, not less than 30 in. nor more than 60 in. above the platform end sill, fastened securely with not less than ½-in. bolts with nuts outside (if possible) riveted over or with not less than ½-in. rivets. They shall be located on caboose cars without end platforms, in the same relative positions as specified for box and other house cars.

Tank head hand holds are required on tank cars with side platforms. Tank cars without side sills and tank cars with short side sills and end platforms. Two hand holds are specified but are not necessary if the safety railing runs around the ends of the tank. They are to be of ⅝ in. in diameter, made of wrought iron or steel with not less than 2 in. clearance. They are to be located and fastened one across each head of the tank not less than 30 in. nor more than 60 in. above the platform or the platform on the running board. They must be securely fastened, not less than 6 in. from the outer diameter of the tank.

Vertical End Hand Holds

End hand holds (vertical) shall be provided on cars with platform end sills (described heretofore) being two in number, not less than ⅝ in. in diameter with the tread not less than 18 in. without weld. The proper clearance is 2 in. and they shall be located opposite the ladders not more than 8 in. from the side of the car and not less than 24 in. or more than 30 in. above the center line of the coupler measured from the bottom end of the hand hold and secured by not less than ½ in. bolts with nuts outside (if possible) riveted over, or ½ in. rivets.

CONFERENCE RULING.

The law makes no distinction between passenger and freight cars, and hand holds must, therefore, be placed on the ends of passenger cars and cabooses.

Horizontal Side Handholds

Side hand holds (horizontal) shall be not less than ⅝ in. in diameter of wrought iron or steel without weld. Four are required. The proper length and clearance of these side hand holds are as follows: The tread must not be less than 16 in. long with a clearance of 8 in. from the end of the car and must be not more than 30 in. nor less than 24 in. above the center line of the coupler where the car will permit.

The following classes of cars are so constructed as not to permit the location of side hand holds as above specified: some fixed end and drop end low side gondolas and low side hopper cars. Side hand holds are to be securely fastened with not less than ½-in. bolts and nuts outside (if possible), riveted over or with not less than ½-in rivets. Ladder treads may act as hand holds. The location of horizontal side hand holds is not the same on all classes of cars, the exceptions being: flat cars, tank cars with side platforms, tank cars without side sills and tank cars with short side sills and end platforms. On the above classes of cars they are to be located not more than 12 in. from the end of the car, one near each end, on the face of each side sill. The four horizontal side hand holds on tank cars without end sills are to be located one near each end on each side of the car on the running board over the sill step. They are to be placed on the running board, not more than 2 in. back from the outside edge, projecting outward or downward. When these hand holds are more than 18 in. from the end of the car, an additional hand hold must be placed near each end on each side not more than 30 in. above the center line of the coupler and the clearance of the outer end of the hand hold shall be not more than 12 in. from the end of the car.

Side hand holds shall be applied on caboose cars with platforms, one located near each end on each side of the car, curving downward toward the center of the car from a point not less than 30 in. above the platform to a point not more than 8 in. from the bottom of the car. The top end of the hand hold shall not be more than 8 in. from the outside face of the end sheathing. They must have the following length and clearance: minimum clear length, 38 in., and minimum clearance, 2 in.

Horizontal side hand holds shall be located on caboose cars without platforms as follows: one near each end on each side of the car, not less than 24 in. nor more than 30 in. above the center line of the coupler. The clearance of the outer end of the hand hold shall not be more than 8 in. from the end of the car.

Vertical Side Handholds

These hand holds are used on all classes of tank cars if equipped with safety railings, and there shall be four located one over each sill step, secured to the tank or tank band.

CONFERENCE RULINGS.

Ladders and hand holds need not be applied to swinging side doors of gondola and ballast cars. A side vertical hand hold shall be placed on the corner post of such cars, as nearly as possible over the sill step.

Vertical side hand holds on ballast cars must be applied to the outside face of the corner post, i. e., the faces of same which are parallel to the sides of the car.

Side Door Handholds

Caboose cars without platforms require these hand holds. They shall be four in number, two curved and two straight, located as follows: one curved hand hold from a point at the side of each door opposite the ladder not less than 36 in. above the bottom of the car curving away from the door downward to a point not more than 6 in. above the bottom of the car.

One vertical hand hold at the ladder side of each door from a point not less than 36 in. above the bottom of the car to a point not more than 6 in. above the level of the bottom of the door. They must be not less than ⅝ in. in diameter of wrought iron or steel, with a minimum clearance of 2 in., securely fastened with not less than ½-in. bolts with nuts outside (if possible) riveted over or with not less than ½-in. rivets.

Platform Hand Holds

Caboose cars with platforms require these hand holds, four in number, one right angle hand hold located on each side of each end extending horizontally from the door post to the corner of the car at the approximate height of the platform rail, then downward to within 12 in. of the bottom of the car. They must be not less than ⅝ in. in diameter of wrought iron or steel, with 2 in. minimum clearance preferably 2½ in. They are to be securely fastened with bolts, screws or rivets.

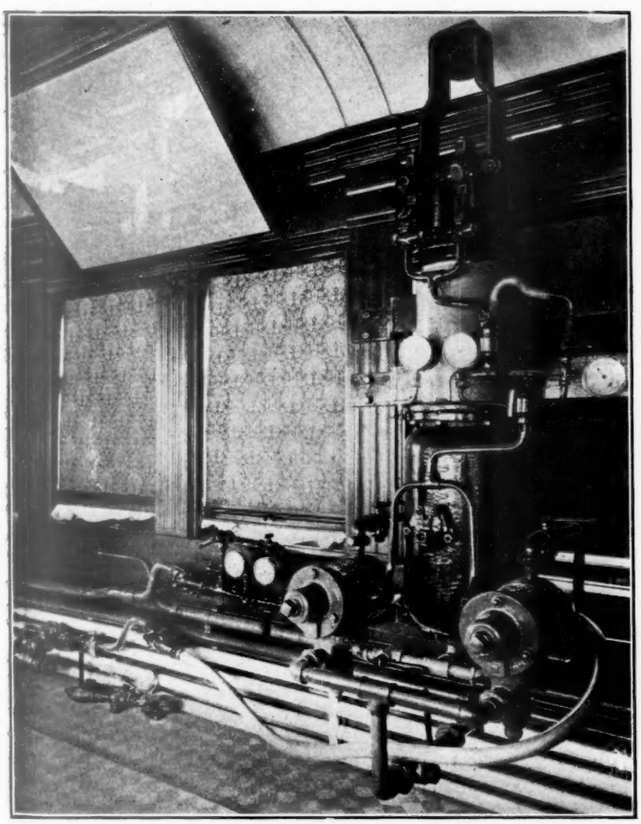
TEST RACK FOR INSTRUCTING AIR BRAKE REPAIRMEN

BY N. J. CLINE
Air Brake Foreman, Pittsburgh & Lake Erie

A novel and ingenious test rack installed in the air-brake instruction car of the Pittsburgh & Lake Erie is shown in the illustrations. This test rack is used for instructing air brake repairmen in the method of testing a car on the repair track for defects in the air brake equipment.

A 10-in. freight brake equipment stands vertically against the wall, with suitable pipe connections and gages to indicate resulting pressures and their changes. Two triple valves, one known to be in good condition and the other known to be in bad condition, or at least a condition that should receive attention, are also connected. The same is true of the pressure retaining valves installed on the top of the air cylinder, one of them being known as a good valve and the other as one needing attention.

To the left of the brake apparatus is a device for testing



The Air Brake Testing Device Installed in the Instruction Car

brakes on single cars, which is permanently installed as a part of this rack, but is, in detail, exactly like that used by the repairmen on the repair track.

The repairmen are brought into the car in classes, and each man is asked to test out this car equipment, locate any defects, if they exist, and indicate what should be done to overcome them. Brake cylinder leakage can be varied, and either the good or bad triple valve or pressure retaining valve can be cut into the equipment.

The code of tests used with this rack is that for freight brake triple valves, which is as follows:

The tests are to be made with 80 to 90 lb. pressure in the supply line and with the single-car test apparatus.

Test for Testing Device.—Before coupling the testing device to the brake pipe hose, close cocks *1* and *2* and open the cock in the supply pipe. There should be no escape of air from the coupling at the end of the test device.

Coupling Device to Car.—Connect the coupling *A* to the brake pipe hose at one end of the car; to the other end on the opposite end of the car couple on a dummy coupling, which should be provided for this purpose. Open both angle cocks, then open cock 1 and charge the brake pipe and the auxiliary reservoir to 70 lb.

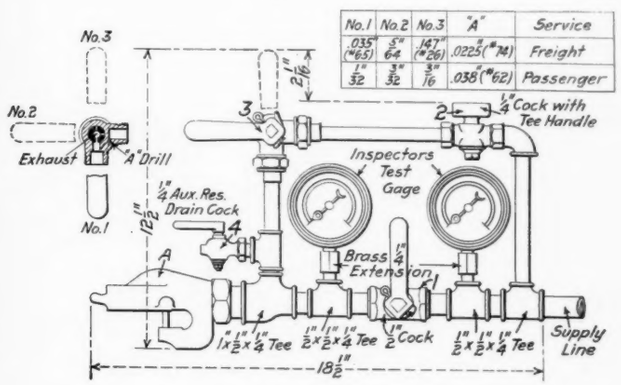
Brake Pipe Leakage Test.—Close cock *1*, open cock *4*, reducing the brake pipe pressure to 60 lb., then close cock *4*.

Observe the pressure on the brake pipe gage. Leakage in the brake pipe will be indicated by a drop in pressure, which should not exceed 3 lb. in one minute.

Auxiliary Reservoir and Graduating Valve Leakage.—During the brake pipe leakage test, if the triple valve releases the brake, it indicates either a leaky graduating valve or a leak from the auxiliary reservoir or into the brake pipe past cocks *1* and *2*.

Application and Release Tests.—Open cock *1* and charge the brake pipe and auxiliary reservoir to 70 lb. Then close cock *1* and move the handle of cock *3* to position No. 1, reducing the brake pipe pressure to 60 lb. The brake should apply before the brake pipe pressure is reduced to 60 lb. Failure of the brake to apply indicates that the triple valve should be removed for further investigation on the triple valve test rack.

Release Test.—If the brake applies, as specified in the



Device for Testing Air Brakes on Single Cars

Application Test, and brake pipe pressure is at 60 lb., open cock *2*. The brake should release in one minute. Failure of the brake to release in the time specified indicates that the triple valve should be removed for further investigation on the triple valve test rack.

Service Stability Test.—Charge the brake pipe and the auxiliary reservoir to 70 lb., then close cock *1*. Move the handle of cock *3* to position No. 2, reducing the brake pipe pressure 20 lb. This test should not produce an emergency application of the brake. If an emergency application is obtained by this test, it indicates that this triple valve should be removed for further investigation on the triple valve test rack.

Emergency Test.—Charge the brake pipe and auxiliary reservoir to 70 lb., then close cock *1*. Move the handle of cock *3* to position No. 3, reducing the brake pipe pressure to 20 lb. This test should produce an emergency application. If an emergency application is not obtained, it would indicate that this triple valve should be removed for further investigation on the triple valve test rack.

It has been found that instruction by means of this rack has resulted in a far better understanding on the part of the repairmen as to the purpose of the tests made on the repair track and the importance of making repaired equipment pass

these tests before the car is released. With the exception of the single-car testing device, all of the apparatus was obtained from stock and required very little special application.

THE DEVELOPMENT OF PULLMAN TRAFFIC

Since the publication of the article in the January issue of the *Railway Mechanical Engineer* dealing with the needs of the railroads for additional passenger equipment, more data has become available which throws some light on the relative development of traffic carried in railroad and in Pullman passenger cars during the last 15 years and of the increase in the number of Pullman cars which has been made to keep pace with the growth of sleeping and passenger car traffic. In the absence of this information the discussion in the article referred to was confined to equipment of railroad ownership only.

During the ten years ending on July 31, 1915, the number of passengers carried in Pullman equipment increased from 14,969,219 to 21,489,301, or 44 per cent. During the same period the number of cars of all classes owned by the Pullman Company increased from 4,138 to 7,303, or 76½ per cent, but the performance of these cars as measured by car miles showed a proportionately smaller increase of 57 per cent. The number of car miles during the year ending July 31, 1905, was 444,986,296, while for 1915 it was 700,480,779.

At the close of the fiscal year ending July 31, 1919, there were 7,622 Pullman cars of all classes which during the year had carried a total of 33,103,307 passengers and had made 734,031,856 miles. An increase in the number of passengers carried during the four years since July 31, 1915, of 54 per cent has been handled with an increase in the number of cars of 4.4 per cent and in the number of car miles run during the year of slightly less than 5 per cent.

It is unfortunate that there is no record of the number of passenger miles made by travelers in Pullman cars. To determine what the actual traffic increase has been, involves a knowledge of the average miles per passenger trip as well as a knowledge of a number of passengers carried. The best data available on this point are the average receipts per passenger as reported by the Pullman Company. During the seven years from 1911 to 1917, inclusive, the average receipts per berth passenger were $2.47, with a minimum yearly average of $2.43 and a maximum of $2.53. The average receipts per seat passenger were 62 cents for the entire period with a minimum yearly average of 60 cents and a maximum of 63 cents. An estimate of the actual mileage per passenger on the basis of these figures would be complicated by the fact that the average receipts per berth passenger are a weighted average of the rates for uppers, lowers, staterooms and compartments. The uniformity of the proportion of passengers for each of the two classes of Pullman cars and of the average receipts per passenger during the period mentioned seems to justify the conclusion that there was little change in the average miles traveled per passenger during the normal years preceding the war, and that the number of passengers carried may be considered approximately proportional to the number of passenger miles in each year.

It is evident that during the ten years prior to July 31, 1915, there was an increase in the number of Pullman cars greater than the increase in traffic seemed to demand. This is explained by the fact that during this period the construction of steel sleeping cars was developed to a practical point and coincident with the large increase in the number of steel passenger cars of railroad ownership a large number of steel Pullmans were built. These replaced the older wood equipment on many roads, particularly the large eastern roads, but the wood equipment was not actually retired from service. The number of cars in service in 1915, therefore, indicates an actual surplus of available equipment, part of which, however, could not be considered available for universal service. This is indicated by the fact that while the number of Pullman passengers per car per year was 3,620 in 1905, it had dropped to 2,940 in 1915. Likewise, the miles per car per year had decreased from 107,600 in 1905 to 96,000 in 1915.

Developments during the last four years, however, have materially changed this situation. With an increase in the number of passengers carried in Pullman cars of 54 per cent, there has been an increase in the number of cars of but little more than 4 per cent. It is true that this has been accompanied by almost no increase in the number of miles per car per year, each car making but 96,400 miles during the year ending July 31, 1919, as compared with 96,000 during the fiscal year 1915. There has, however, been an increase in the number of passengers per car per year from 2,940 to 4,340. This represents a 17 per cent increase in the number of passengers per car per year as compared with 1905, and such data as is available indicates that the ratio for none of the years prior to 1915 varied much from that of 1905. That this increase in service was effected without a material increase in the miles per car clearly reflects the results of the Railroad Administration's policy of filling sleeping cars, uppers and lowers alike.

There are two reasons which make difficult any attempt to arrive at a close estimate of the additional amount of sleeping and parlor car equipment required to meet the needs of the present and immediate future on the basis of past developments: first, the abnormal increase in the number of cars built during the decade prior to 1915, and second, the possibility of much greater utilization of the equipment than was ever developed during the pre-war years. Much of the wood equipment which has long been in use has rendered invaluable service during the war in the movement of troops. The gradual extension of the use of steel equipment, however, probably will considerably exceed the actual need for new cars, and it is inevitable that the surplus wood equipment must be of rapidly decreasing usefulness under normal conditions. It is also probable that with the return of the railroads to private operation the full effect of the lesson in efficient utilization of sleeping car equipment will not be retained by the public and there will be a demand for some choice of accommodations, which has been denied the traveler during the past two years. An increase in the number of cars sufficient to reduce the number of Pullman passengers per car to 4,000 on the basis of the business handled in 1919 alone would require about 700 additional cars, without considering the question of retirements, while to retain this ratio with an increase in traffic during the next few years proportional to the average increase which took place during the decade prior to 1915 would require almost 1,000 more.

This cannot be considered a close estimate, but it certainly may be considered as indicative of the fact that a large number of Pullman sleeping and parlor cars will be needed during the next few years to take care of the demand of the traveling public for a return of some measure of the choice of accommodations enjoyed before the war and to meet the inevitable growth in the passenger traffic of American railroads.

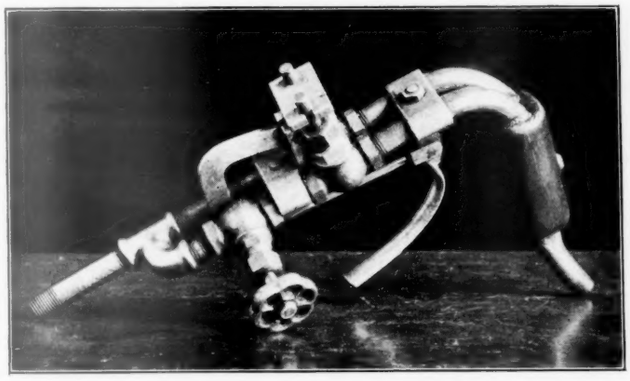
Spain Has Too Much Coal.—Spain, in common with most European countries, has a coal problem, but its situation is diametrically opposite to that of its neighbors; that is, it has a supply greater than the demand. Piled up at the heads and in the coal ports of Asturias lies a stock estimated at from 750,000 to 1,000,000 metric tons (metric ton equals 2,204.6 lb.), and the problem of the moment is how to dispose of this surplus.—*N. Y. Tribune.*

PAINT PIPE LINES IN A CUBAN CAR SHOP

Unique Device for Mixing and Spraying Used with Great Success by the United Railways of Havana

BY J. P. RISQUE*

CLAIMS for new high records in production being generally accepted with certain reservations, the statement that box cars are being painted in eight minutes will be received with interest. A further claim for painting 40 coal cars complete in 3½ hours would probably neither add nor detract from the reader's faith in the first statement. But if he were informed that these records had been maintained for over two years in a section of Latin-America in which he had long believed railroading, in the modern sense of the word, was an unknown art he would attach incredibility to the report. The fact is, however, that the United Railways



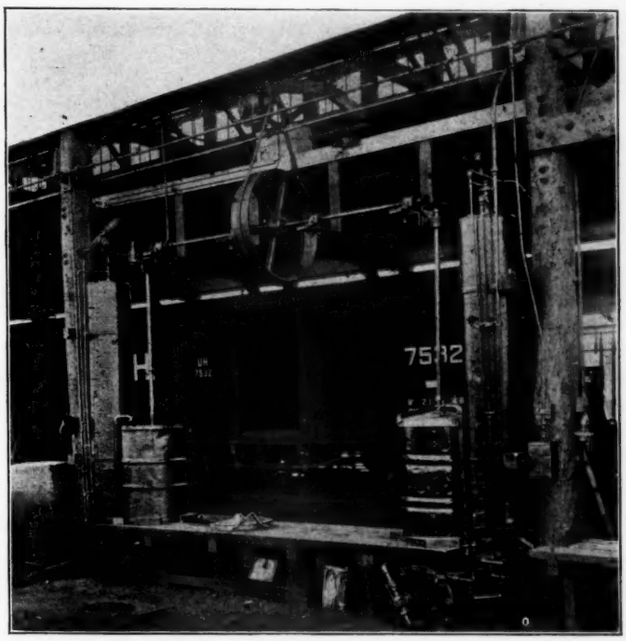
The Paint Gun Is Simple But Effective

of Havana have maintained this schedule at their Luyanó shops for the period of time mentioned.

The home-made paint mixing and distributing apparatus described in this article was originated and installed by Ben F. Elliott, master car builder of the aforementioned lines, and is doing efficient and regular business for the company every working day of the year. Coupled with the fact that its successful operation is not particularly enhanced by the temperaments of the operators to be found in these parts, most of whom would—and frequently do—relapse to the brush on the slightest provocation, the record can be truthfully said to be phenomenal. Constructed of such miscellaneous and second-hand material as is generally procurable in a large car plant, it is unique in design and simple in operation.

The machine's general arrangement is well set forth in the photograph which accompanies this description. It will be noted that the space occupied by the whole outfit is one which does not conflict in the least with the conduct of the business of the shop. The installation as arranged in reality comprises two paint machines—one for mixing and distributing red paint under air pressure, the other for black, the parts for one end being interchangeable with the other. Three principal features of the device mark it as a combination which is a distinct contribution to the art. The first feature is that of delivering paint ready for use in a spray gun anywhere along a pipe line 600 ft. long or even longer. The second, and perhaps an equally important one, is its function as a paint mixer and the consequent elimination of the tired workman and his hand-stirring paddle. The third point in the combination is the construction of the spray or paint gun, which differs sufficiently from stock varieties to make it noticeable.

The mechanical movement provided is solely for the purpose of operating the churns in the mixing tanks, power being derived from a two-horsepower electric motor driving a horizontal shaft through a flywheel. The shaft, mounted on suitable hangers and running in oil boxes fastened thereto, carries a bevel gear on its end. This gear drives its mate and revolves the vertical propeller shaft, which, anchored in a bearing near its top, seats in a collar in the bottom of the mixing tank—in this case an ordinary so-called "one-time" oil drum. A two-blade propeller is fixed near the base of the shaft and runs as close to the bottom of the tank as is practicable without scraping. The blades are pitched to force the agitation upward, and ¾-in. holes in the blades add to their mixing effect. The propeller blades are made from sheet iron and the relation of the motor driven shaft to the flywheel and proportions of gears, have been calcu-



General View of the Churns and Pressure Tanks

lated to revolve the blades at a speed of from 50 to 60 r. p. m.

Close-fitting removable sheet iron covers for the mixing tank admit of the introduction into the tank of the necessary quantity of paint and oil. When the covers are in place they prevent waste of paint by splashing.

The cylindrical tank below the churn is a receiver into which the mixed paint is allowed to flow by gravity upon the opening of the valve between it and the churn. The receiver is constructed of an old cast-iron flanged pipe and the heads are of wood, bolted into place as shown, with a sheet-iron outside cover.

Compressed air from the shop supply is admitted into the receiver through a reducing valve which cuts the pressure

*Mr. Risque is making a trip through Cuba and Central and South America as an editorial representative of the *Railway Mechanical Engineer*. In future issues we will publish other articles describing the interesting practices which he finds on the railways of Latin America.

down to 60 lb. per sq. in. The valve between the churn and the receiver is closed and the valve from the receiver to the pressure tank opened, and the paint is forced into the latter and out into the pipe line, which can be seen strung along the posts in the photograph. Stations are arranged at convenient intervals along the pipe line, and branch drop pipes bring the paint supply within easy reach of the operator. Painting a whole string of cars along the 600-foot line is then simply a matter of attaching the working hose carrying the paint gun, opening the valve and directing the spray.

As each station is provided with two drop lines with valves, one for a supply of red paint, the other for black, with double valves for air-pipe connections, painting in both colors on trucks and bodies can be carried on simultaneously, and the operation is not confined to one station. In the case of a rush, the number of stations operated is a matter of the supply of paint guns and hose.

Particular attention is directed to the construction of the paint gun, shown in the photograph, which is unique and consists merely of two brass pipes clamped together. The straight pipe carries air at 80-lb. pressure direct from the shop air line. The pipe which is seen to turn into the former carries the combination of paint and air at 20 lb. less pressure than the air pipe, or 60 lb. direct from the pressure tank via the pipe line. It will be realized that, although the paint in the line is under sufficient pressure of air to cause it to rush out of an open valve—in this case, the nozzle of the gun—it is, in reality, comparatively inefficient.

It is only through the energizing influence of its contact with an 80-lb. blast that the mixture assumes the required character to effectively carry it from the gun to the side of the car to be painted. The gun trigger, operated by the workman's finger, lifts a plate which bears against the stems of the two valves, one controlling the paint-line supply, the other the 80-lb. air pressure supply. Each valve is raised against the resistance of a small coil spring. As the spring on the straight air pipe valve is purposely somewhat weaker than the spring on the paint-line valve, it is obvious that in pulling the trigger the air line will open first. By this means the 80-lb. air blast is started first. Further pressure on the trigger causes the paint-line valve to yield and commence to admit its contents into the air blast, and the finished mixture rushes out of the end of the gun.

Accumulation of paint in the pipe lines is prevented by "blowing back" through the line. At either end of the 600-ft. run of pipes the two are joined by a tee. The third opening of the tee contains a nipple, with a cut-out valve on it. When this valve is opened, as well as either or both of the valves near the end of both red and black pipe lines, 80-lb. air is blown back through the line—or both lines if desired—

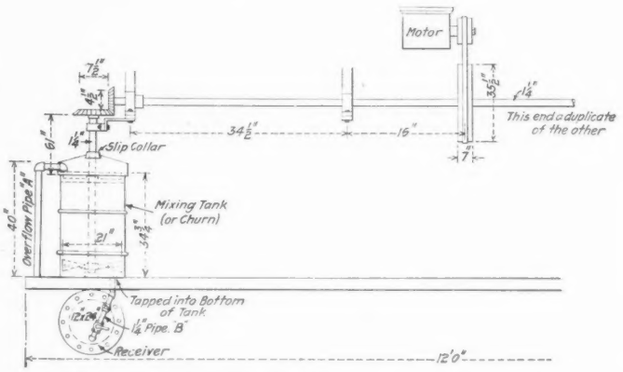


Fig. 1. Arrangement of Mixing Tank and Reciever

past the check valves, also near the end of the lines, and through the opened pressure tank valve into the pressure tank. A special discharge pipe and valve from the pressure tank carry the blown back residue to its original point, the mixing tank. If the paint line happens to become clogged, an incident which has not transpired in two years, provision is made for introducing five gallons of turpentine into the whole system to clean it out. Cleaning out the work hose, which is carried around by the operator and has the gun attached at one end and connects at the pipe line station and air valve at the other, is merely a matter of screwing a cap on the end of the spray nipple and pulling the trigger. The 80-lb. air will quickly blow the 60-lb. air and paint back out of the hose.

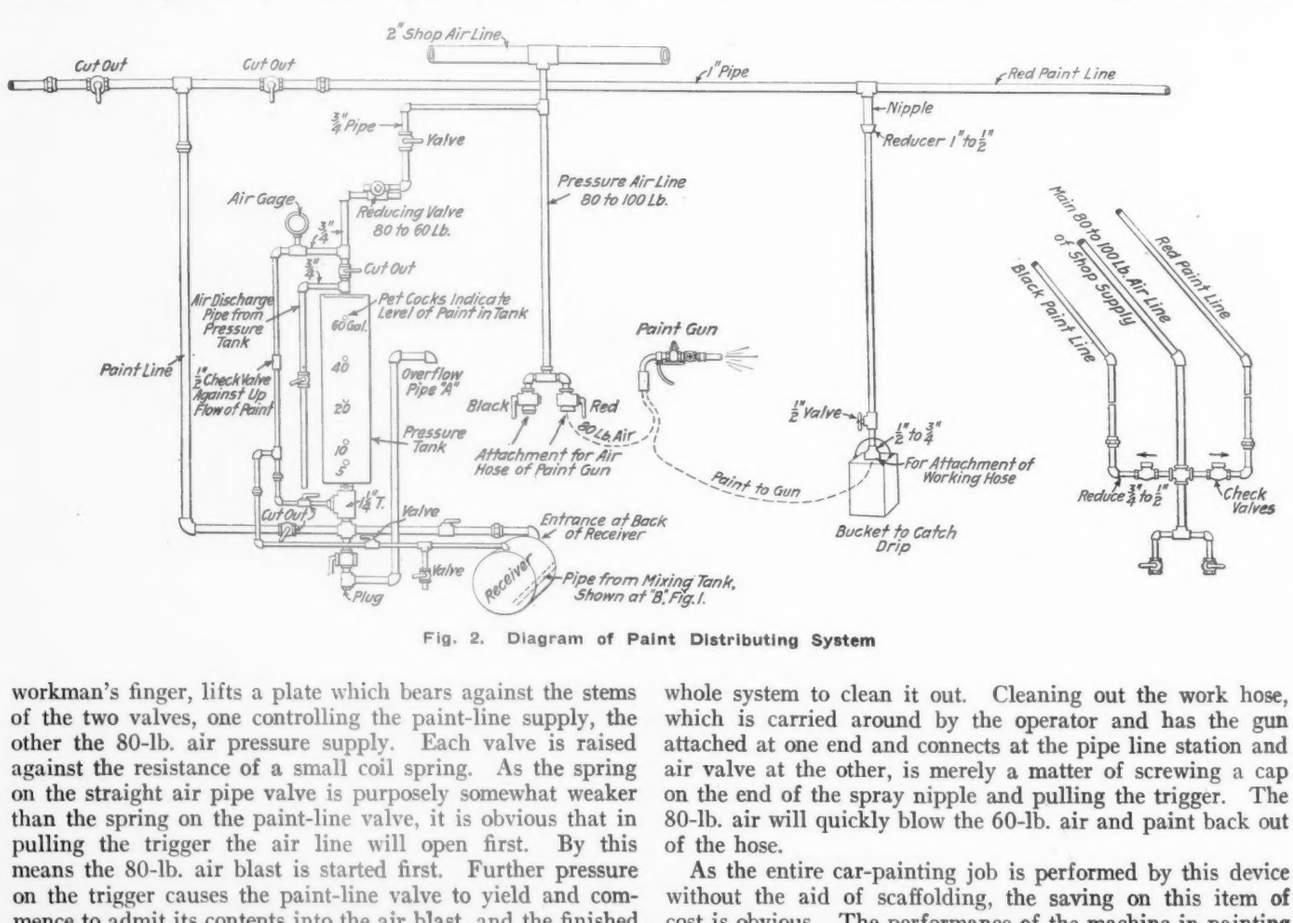


Fig. 2. Diagram of Paint Distributing System

As the entire car-painting job is performed by this device without the aid of scaffolding, the saving on this item of cost is obvious. The performance of the machine in painting over 3,000 cars in the last 12 months is characterized by an

absence of the waste of paint which so often accompanies the use of spray painters to a certain degree. No evidence of paint, either spilled or sprayed, is apparent anywhere along the run of tracks where the job is daily handled. The delivery from the tip of the gun is paint thoroughly atomized, its rate of flow does not vary, and the volume of effectual delivery seems to be sufficient to keep the operator on the move.

HANDLING WRECKS AND DERAILMENTS INVOLVING LOADED TANK CARS*

BY W. S. TOPPING
Assistant Chief Inspector, Bureau of Explosives

The loss and damage to life and property, due to the transportation of gasoline during 1918, exceeded many times the loss and damage due to the transportation of the unusually large volume of explosives required to meet war conditions. The average ratio of these losses is about twenty to one. The weight of gasoline shipped under normal conditions is about forty times the weight of explosives of all kinds, and during 1918 the weight of gasoline was about ten times that of explosives. When a comparison is made on the basis of actual weights shipped, during normal years the average transportation losses due to a pound of explosives have been about two times the losses due to a pound of gasoline, but during the year 1918, when abnormal quantities of explosives were shipped the losses due to a pound of gasoline have been two times the losses due to a pound of explosives.

The clearing up of wrecks of tank cars of gasoline and other inflammable liquids involves peculiar risks, owing to the large volume of contents in individual cars and the volatile and inflammable nature of these contents. Owing to the wide diversity of conditions that may exist in such wrecks it is not practicable to draw up regulations which will insure safe handling in all cases. The records of the Bureau of Explosives show instances of ignition of inflammable vapors reported to have taken place at varying distances from the points of leakage. In some instances these distances have been as great as 480 ft., while in others the distances, of course, have been materially less.

Gasoline varies in hazard from the wild and highly volatile casing-head gasolines to the ordinary refinery gasoline. Under ordinary atmospheric temperatures the former gives off many times the amount of vapor in a given time as does the latter. In hot weather all gasolines vaporize more rapidly than in cold weather, but even in the coldest weather gasoline gives off inflammable vapors in sufficient amount to ignite rapidly.

The vapor of gasoline or other inflammable liquids is much heavier than air and tends to form a layer along the ground and only mixes slowly with the air. The mixing with air is increased by wind. The vapor flows along the ground tending to follow the slope of the ground and settles in low places. It will not drift or flow to any extent against the wind, but may travel a considerable distance with the wind. Owing to variations as to volatility of gasoline, amount of gasoline exposed, temperature, contour of ground and direction of wind, it is impossible to fix any definite limit at which the hazard of ignition ceases.

In handling wrecks involving tank cars of gasoline, leaks should be stopped if possible, or the contents of the car transferred. While gasoline is actually escaping all lights and fires should be kept at a distance, this distance being much greater on the leeward side than on the windward. Any necessary lights should be kept in elevated positions. The passage of trains on adjoining tracks or the near approach of the wreck crane is unsafe, until the leakage can be controlled and the gasoline which has already escaped can be drained away and the saturated area covered with a layer of earth or cold cinders. Even after this is done sufficient time should be allowed to permit the evaporation of any loose liquid, and the diffusion of the vapors, so that they are no longer present in dangerous amount.

When the gasoline is escaping in large quantity, the situation is extremely dangerous and the first steps taken should be to police the location; to cause the removal or prevent the approach of all lights or fires other than closed electric lights; to keep all unauthorized people away. Next, steps should be taken to control the escape of gasoline, if possible, and if not, to dispose of the gasoline which has escaped, so that it will no longer be hazardous. This is generally best done by draining into holes dug in the ground, and then when the liquid has drained away, filling back the loose earth. Care should be taken to avoid permitting large amounts of gasoline to flow into sewers or water courses, as in this way the hazard may be carried long distances from the original point of trouble. After this the usual steps may be taken, using the precautions of keeping lights from the immediate neighborhood of the tank car and if possible bringing the wreck crane up from the windward side.

The precautions suggested will inevitably cause delay in the removal of wrecks, and opening the line; but there is no possible way of safely handling such wrecks while tank cars are leaking gasoline copiously, or gasoline which has already escaped in quantity is still uncared for.

The following general rules will serve as a guide for the majority of cases:

1. Post guards and keep all speotators away.
2. Locate all leaks and stop them if possible, using only electric flashlights or electric hand lanterns when lights are necessary. If open flame lights must be used keep them elevated as much as possible.
3. Dig holes and trenches to bury exposed and leaking gasoline that cannot be transferred promptly to tight containers.
4. Allow reasonable time after stoppage of leaks and burial of gasoline for vapors to escape from the wreck and vicinity.
5. Keep steam crane fire to windward as much as possible and not less than 500 ft. away until completion of work to this point.
6. First move to safety the least injured cars to avoid starting new leaks during handling by crane. When leaks are to be expected in handling, empty the car first either by transfer of contents to other car or container, or by drainage to a hole or trench in the ground for burial.
7. Do not allow trains to pass on adjoining tracks, especially on same or lower level, as long as gasoline is leaking or exposed in quantity. When allowed to pass keep fire doors and ash pan slides closed and draught shut off.
8. The placing of leaking tank cars for repairs in close proximity to shops where fires or naked lights are maintained must be avoided.

SPECIAL PRECAUTIONS FOR CASINGHEAD GASOLINE

The foregoing refers particularly to ordinary refinery gasoline and other inflammable liquids of low flash point, but should not be taken to include casinghead gasoline, either blended or unblended. Such cars, under the I. C. C. Regulations, are required to show special placards on two sides of the dome and on the dome cover, reading as follows: "Caution. Avoid Accidents. Do not remove this dome cover while gas pressure exists in tank. Keep lighted lanterns away."

In handling situations involving such cars, the first procedure is to release very carefully any accumulated interior

*From a paper read before the sixth annual meeting of the Railway Fire Protection Association, held at Chicago, November 18, 19 and 20, 1919.

gas pressure. This should be done by raising the safety valve stem by engaging the end of the metal rod in the eyelet in the top of the valve stem and prying downward against the outer edge of the top of the spring case. Before doing this the tank should be carefully jacked into normal position, or so nearly as to bring the safety valve above the level of the liquid, other wise the liquid instead of the gas will be forced out. Not until the gas pressure has been relieved can arrangements be undertaken with safety to begin the transfer.

If the wrecked tank is not broken or leaking the contents can be transferred by air pressure. This is best accomplished by using a special dome cover with two openings through which pipes are tightly fitted. One of these pipes extends a few inches inside the dome and is used for the air pressure feed; the other passes to the lowest part of the tank and acts as a discharge. If a special dome cover is not available and a machine shop is located in the vicinity of the wreck the dome cover of the car can be prepared as described above in a short time.

Highly volatile products such as casinghead gasoline cannot be transferred in the usual way by an ordinary vacuum pump. As soon as such a pump creates a partial vacuum the vapor from the liquid fills it and for this reason only vapor will come through. A pump can be used, if connected so that the liquid will flow from the tank to the pump by gravity. Before connecting the pump with the bottom outlet relieve all pressure through the safety valve, and then remove the dome cover and carefully verify the setting of the outlet valve stem.

If it is necessary to bury the liquid dig trenches deep enough to keep all of the liquid well below the surface of the ground.

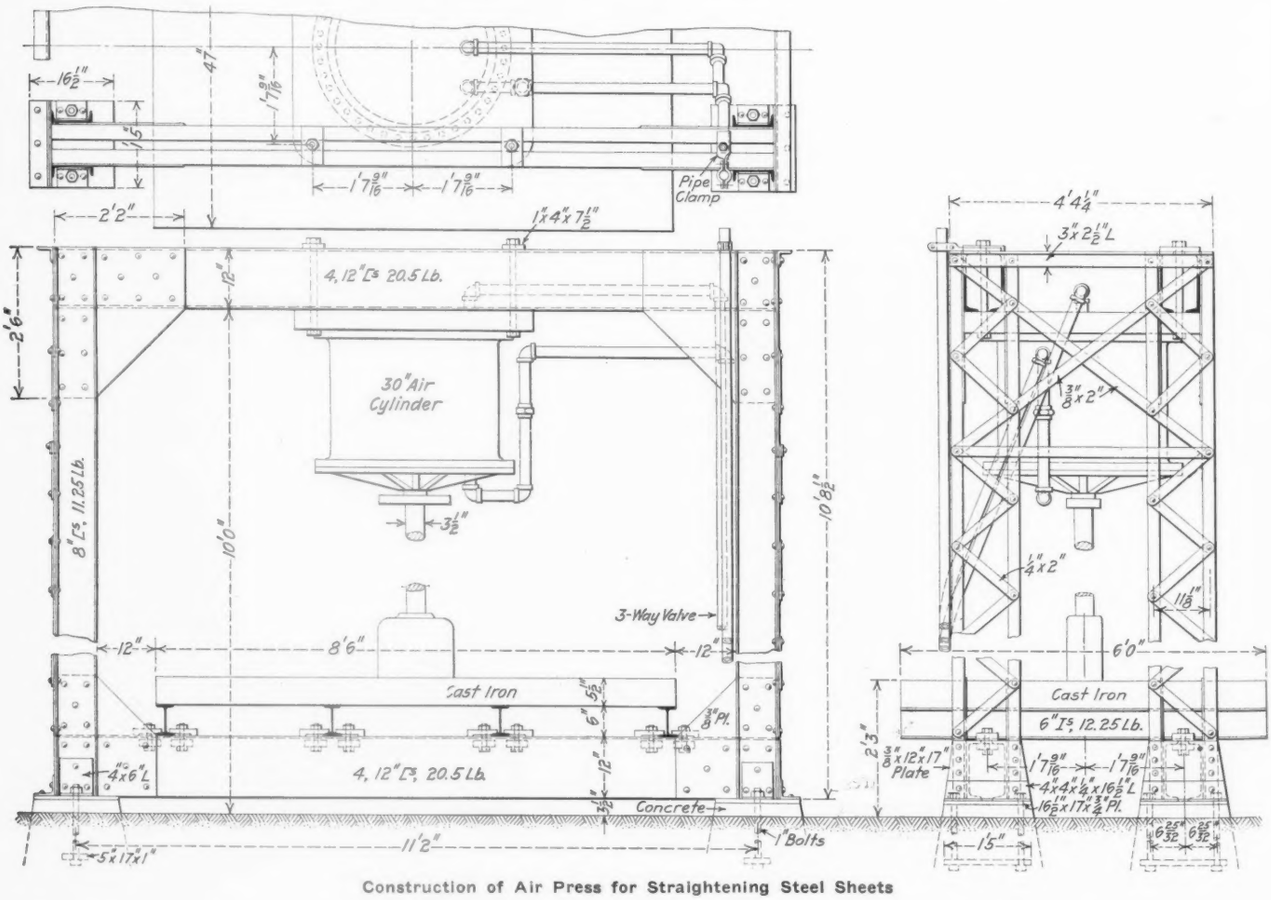
AIR PRESS FOR STRAIGHTENING STEEL SHEETS

BY NORMAN McLEOD

The reclamation of distorted steel parts of cars, particularly the bent sheets of steel cars, is a most important feature in economical car repair work and is being given considerable attention by car repairmen. The air press shown in the drawing is a development brought about by the need of an efficient means of straightening bent steel sheets.

Similar devices have been used, but the press shown has been very successful and a number of them have been built for use in various railroad repair shops.

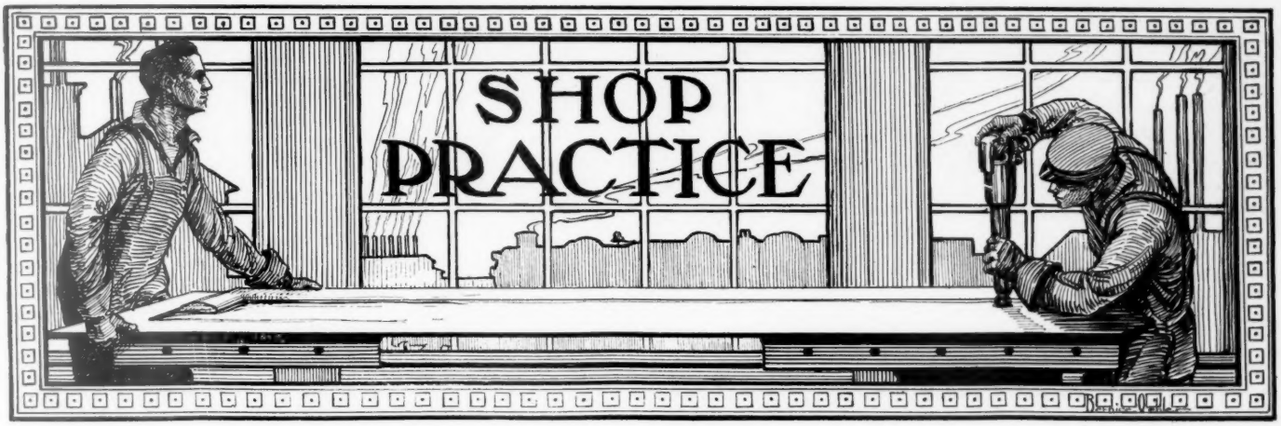
The framing of this air press is built up of steel channels and angles, firmly braced with gusset plates and steel lattice work, and is supported on a concrete foundation. The bedplate of the press is of cast iron and is 8 ft. 6 in. long by 6 ft. wide. It is 5½ in. thick and rests on four 6-in. I-beams, making a most ample and rigid bed for any part of a car that may require straightening.



Construction of Air Press for Straightening Steel Sheets

The air cylinder used in this design is 30 in. inside diameter, with a piston mounted on a 3½-in. piston rod, to the end of which is attached the ram or hammer used in straightening a distorted piece. The cylinder is secured to the top cross members of the press frame by four bolts extending upward between the channels. A three-way valve with suitable piping provides for the admission of air to either side of the piston and for the exhaust of the air to the atmosphere.

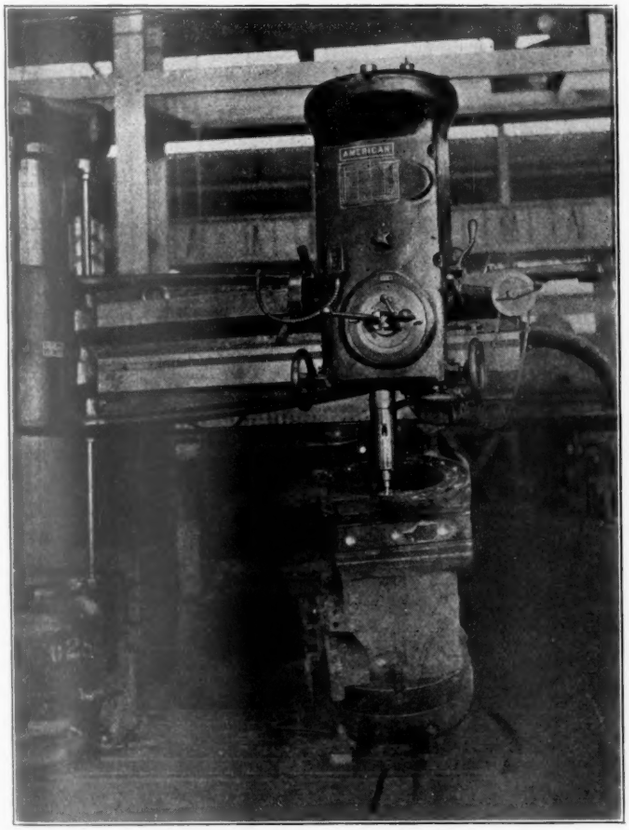
The space between the side frames is 10 ft. 6 in. and the head room above the bedplate is 7 ft. 9 in., providing ample room for the operators and permitting the use of a sledge if necessary.



NOVEL CHUCK ARRANGEMENT FOR HOLDING DRIVING BOX

BY GEORGE BARNSTRICKER

One method of taking up the side play on driving boxes is to recess the face of the box on a boring mill and pour on molten brass, which is later machined to the desired thickness. In recessing the side of the box it is usually



Chuck Set at 30 deg. Holds Driving Box While Holes are Drilled in Hub Face

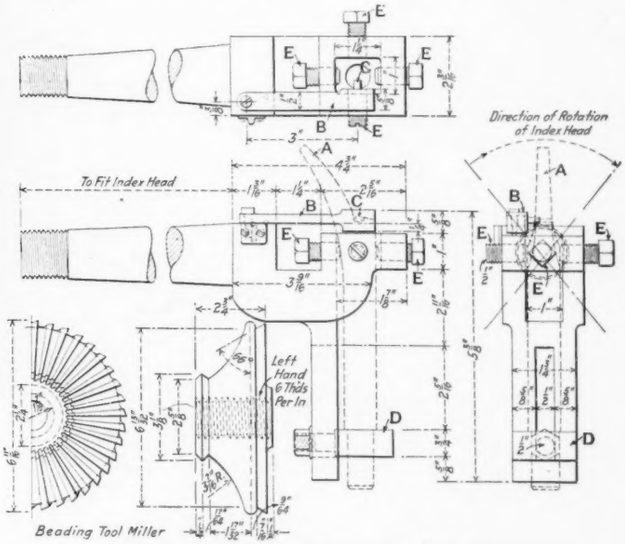
cut under in order to hold the brass in place after it has cooled off. It was found in actual practice, however, that this form of attachment was not sufficient, and a series of 32 holes were drilled around the face of the box at an angle of 30 degrees. These holes need not be of any exact size, but 5/8-in. holes by 5/8 in. deep will be found to give satisfaction and insure the brass hub liner remaining in place.

For the purpose of drilling this series of holes in the driving box face at an angle of 30 deg., the arrangement shown in the illustration will be found a material aid. Two pieces of 5/8-in. by 2½-in. iron are bent to an angle of 30 degrees, and bolted to the base of the drill press, where the driving box drilling work is usually done. An ordinary lathe chuck of large enough capacity to take the largest driving box, as shown, is now mounted on the two pieces of iron and a boss underneath the chuck holds it in place, but does not prevent its rotation. In actual practice, the driving box is mounted on the chuck and clamped as shown in the illustration. The 32 holes are then drilled in the face of the box at a constant angle of 30 degrees by simply revolving the chuck after each hole has been drilled.

JIG FOR MILLING BEADING TOOLS

BY C. W. SCHANE
Instructor of Apprentices, Erie Railroad

The beading of locomotive flues requires careful and accurate work to secure smooth, tight beads so that there will be no leakage and little tendency for honeycomb to form and stop the flues. To do accurate work in beading over the ends of the flues it is necessary to have properly milled bead-



The Beading Tool Miller and the Jig

ing tools. A jig for use in making such tools is shown in the illustration. This jig is made to screw into the index head of the milling machine and when the beading tool is being cut, is adjusted to the proper position to produce the required shape of the tool.

In the drawing the beading tool *A* is shown in outline. A small dog or stop *B* permits the exact duplication of adjustment of the tool by means of the projection or pin *C* on the dog. To adjust a tool in the jig for the milling operation a tool is inserted through the rectangular hole in the top of the jig, with the shank of the tool resting in the adjustable support D. The dog B is then thrown into place at the tool secured in the desired position by the set screws E.

The use of this jig has not only produced beading tools of greater accuracy than it was possible to make by ordinary hand methods, but it has reduced the cost of manufacture from 60 cents to 8 cents each, a saving of 52 cents on each tool.

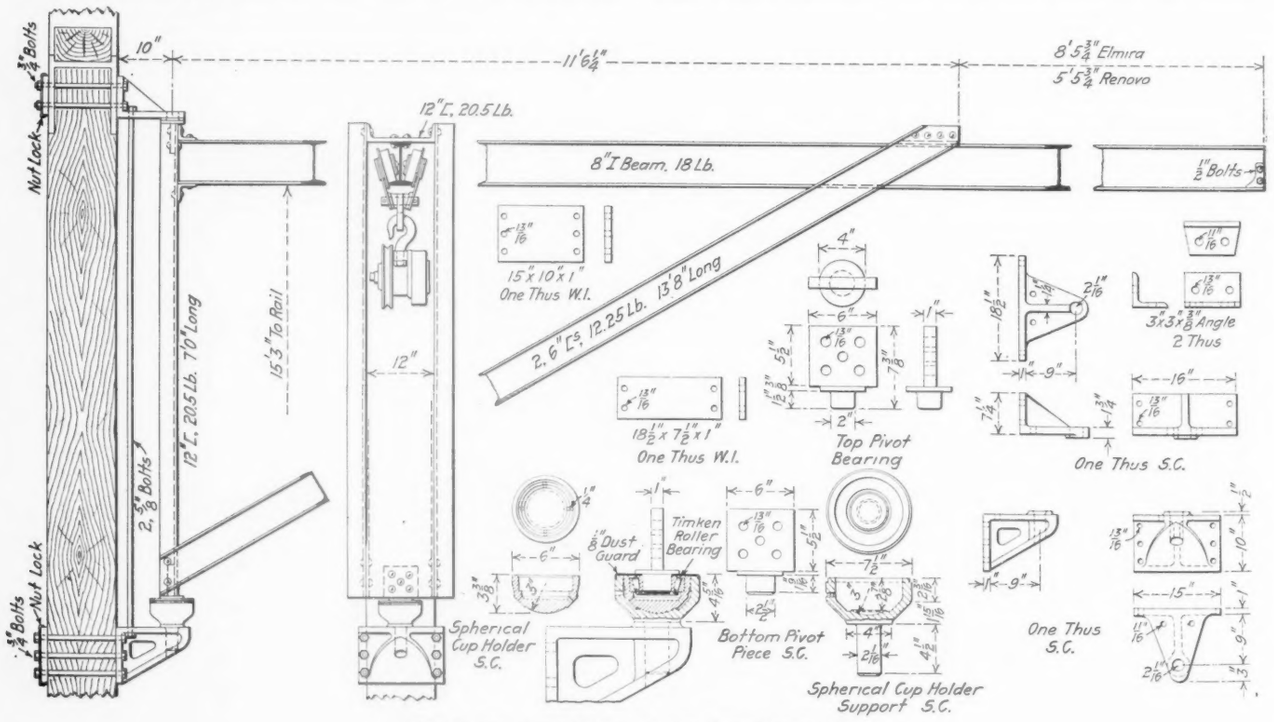
A ROUNDHOUSE CRANE

BY A. P. SHARP

A jib crane for use in roundhouse work was described on page 205 of the April, 1919, issue of the *Railway Mechanical Engineer*. This crane, as first designed and built, facilitated repair work in the roundhouse, but it was found that the friction which developed at the pivots was so great that it seriously interfered with the operation of the crane. To overcome this trouble, those cranes which had already been built were equipped with roller bearings, greatly increasing their utility. The service obtained from these cranes led to a further improvement, and the new design is shown in the accompanying drawing.

In the present type the jib boom was made of an 8-in. 18-lb I-beam instead of a 6-in. 17.25-lb. I-beam as in the original design, a single vertical 12-in. 20.5-lb. channel instead of two 6-in. 8-lb. channels, and the brace is formed of two 6-in. 12.25-lb. channels instead of one. As in the original design, the trolley travels along the I-beam, but the length of this boom, and consequently the range of the crane, has been increased considerably, making it possible to handle more parts at various stages of roundhouse repair work without the necessity of moving the locomotive to come within range of the crane boom.

The castings and other fittings are substantially the same as in the first design, only such changes being made as were necessary to provide for the greater range and for the roller bearings. These cranes installed at alternate posts in the roundhouse will increase the capacity of the house for repair work and will soon return the cost of construction.



Details and Installation of the Roundhouse Crane

PIECE WORK—PRO AND CON.—That the hourly wage basis of payment of wages has not produced as good or satisfactory results to either party as some of the special piece work or premium plans that were previously in vogue, is being more or less generally conceded. A careful canvass made recently by the New York Sun among manufacturers to determine the working out on production of enforced shorter hours and increased wages confirmed the belief of economists that its results are not as beneficial as expected. The theory has been that the worker can produce better goods if allowed to work fewer hours a day than his energy is capable of, providing he received increased compensation for the fewer hours, but the great fault of the scheme is that it does not take into consideration the mental attitude of the individual, and where all are on an equal basis and the sloth receives the same pay as the industrious worker, the latter loses his ambition and allows himself to fall to the level of the slower and lazier partner at his work. In the end the ambitious worker is the loser in following this false precept. Progress cannot be made by retarding production and production cannot be increased by slowing down the individual worker. A far better standard is found in a wage system depending not on a fixed scale for the class of work done so much as in the amount of work produced, which makes the laborer worthy of his hire and puts the individual strictly on his own feet. It is interesting to note that in a recent wage decision the arbitrator denied the demands for the abolishing of piece work. All this would tend to indicate that the turning point has been reached and that a realization that the wages labor receives must be made out of the work labor produces, will bring recognition of the fact that increased and scientific production and payment for same under an individual system, which would give the greatest award to the greatest producer, must go hand in hand.—*Proceedings of the Car Foremen's Association of Chicago.*

THE OLD WAY AND THE NEW; A CAR SHOP STORY*

Autocratic Management Proved a Failure, But An Entire Change of Policy Brought the Desired Results

BY THEODORE RUDOLF

THE first year of our part in the world war had just come to a close when Sidney Stevens stepped from the train in a small Southern town. Endowed with youth, strength, good looks and an active mind, but of a roving disposition, he could never stay long in one place, but drifted about as his fancy dictated. Never having learned a trade fully or having acquired more than a superficial school education, his ambitious mind could not take root in the general occupations open to him. Raised on a farm, an orphan without family ties, he had run off in his fifteenth year to follow the lure of the wide world and had worked his way in numerous callings.

An inborn love for mechanics had kept him for the most part engaged in mechanical work, but having had no training, he could never attain any higher degree to satisfy his ambition, and soon would quit, dissatisfied. Drifting into the war industries, he had worked in several munitions and other factories, but the automatic, soul-killing sameness of his daily tasks there irked his independent spirit to distraction. Earning much more money than his simple habits required, and without any friends of more refined tastes, he would squander it in reckless fits of riotous living, which would only leave him with a greater feeling of dissatisfaction with himself and the world in general. After one of these wild sprees, disgust with it all took him so forcibly that he quit his job and boarded a train south, with the intention of putting as much space between himself and his former haunts as possible.

Awaking one beautiful Southern morning in the train, the country and this little town took his fancy and he decided to terminate his travels on the spot. Aimlessly drifting out from the depot, he noticed the railroad shops nearby, and his love for all that was mechanical tempted him at once to look them over and led him directly into the car shops His keen, observing mind soon found much of interest. Watching the men here doing carpenter work, there drilling holes in steel beams, others welding truck bolsters or riveting plates, he was quickly struck with the many-sided operations in this work, which would surely leave much to a man's individual creative mind and ingenuity. On inquiry he learned from the men that at the present time help was so badly needed that almost anyone who could swing a hammer would get a job, without regard to previous experience. They advised him to see the foreman of the car department or the general foreman about it, and pointed out the latter to him, who happened to be standing nearby. Sidney at once followed the advice, and soon had his paper and check number, showing that he was employed as an inexperienced car repairer.

Having secured a boarding place, he returned in his overalls, ready for work, and, approaching the foreman of the car department, tendered his paper and reported ready for duty. The foreman, a gruff looking, elderly man, hardly gave him a look, took the paper and walked off, as if he had some important business elsewhere. Sidney waited in the office, and during the next hour the foreman passed by him several times without paying the slightest attention to him. Not knowing what to make of this, Sidney asked one of the men working nearby how he could get started on work.

"How did you happen to be hired?" asked the man.

"Why," answered Sidney, "I asked the general foreman for a job and he hired me and sent me here."

"Well," laughed the man, "that is just where you rubbed the boss against the grain. You see, our boss is a good old man all right and would not hurt a cat, but he has a chronic grudge against himself and all the world, and he's so jealous of his little authority that he's always afraid some one above him is meddling and stepping on his toes. If you'd asked him first for a job he would have sent you to the general foreman for him to hire you, and you would be O.K. with him. Now you'll have to be patient until he softens up again, and I'll tell you what'll happen. You just stay right there and look as if you don't care how long you stay; your time goes on the payroll just the same. First thing the boss will bounce down on you and give you a long lecture about the G. F. and everybody else trying to interfere in his business, and give you to understand that it's a pity for the company that they let them do it, since he himself is the only one that knows anything about the car business, but is not given a chance to show it, and nobody appreciates what a fine car shop foreman he is and how hard he works, and so on. Then, when you are well soaked with all this valuable information about himself, he'll put you to work with one of the men and pay no more attention to you, except that he'll tell some of us fellows that the general foreman has again shipped him another greenhorn that doesn't know a bolt from a 20-penny nail. But don't let that or anything else that seems strange around here worry you. As long as you're hired you're on, just so you do something to look busy."

It soon turned out exactly as the man had predicted, and after being thoroughly inundated with the foreman's troubles he was put to work as partner to an old-timer—a ruddy, rough-looking Southern cracker named Ben Simmons. On short acquaintance Ben proved to be an honest, whole-souled, good companion, who knew his business thoroughly. Good-natured, but with little education or refinement and having spent the greater part of his life in car shops, he had the pride and enthusiasm of his trade that is bred by ignorance of all other callings. Soon he had taught Sidney the tricks of the trade and felt proud of his willing and quick-learning pupil, so that together they turned out work in excess of the other men, and took commendable pride in the fact.

Sidney's many-sided experience soon showed him that there was notihng extraordinary for one of his bright and observing mind in his new calling, even if the foreman and other men tried to convince him that it would take years and years to learn all they claimed to know about it. Often he would try to get some more information about different phases of their work from the foreman, but only received scant replies, given in such a sarcastic way that he desisted and tried the assistant foreman. This man, he soon noticed, was willing enough to give him information, but, like the rest of the officials, seemed to be always afraid to be caught by one higher in rank and lay himself open to the suspicion of knowing too much.

When talking to Ben about this, he laughed and told him not to pay any attention to fellows that thought more of their job than their work any time.

"Don't you never," said Ben, "look for any satisfaction for what you do if any of them can grab it away. When we used to work piece work times were lots more satisfactory

*Entered in the *Railway Mechanical Engineer's* prize story contest which closes on April 1.

than this, because then your pay check would show whether you were doing something or not. A man had to produce the goods to get anything then. Now any old clodhopper can get in here and soon gets the same wages as we old-timers get, when half of them ain't worth 15 cents a day. Just look at those two fellows over there, working their second day on a pair of draft timbers, the same as we got out in four hours yesterday. But what did we get for making such time? The boss sneered about it, saying that we might have used better timber, when he himself sent us the stuff here to make them. And there he stands, talking with those fellows now for a half hour about some philosophy or other that nobody understands, but all listen and the work just waits till he gets done. When I go to him and ask him to rush us some material we need badly, he'll tell me I am always meddling and interfering in the yard. I'll tell you this is the worst place for asking any questions of anybody, because everybody is scared his answer might be held against him by some one higher up, so you see everybody pussy-footing about the other fellow trying to find out things without having to ask questions."

Sidney, listening to these wise counselings, had a slight feeling of disgust at the hypocrisy of the whole works.

Suddenly his attention was attracted by seeing a young girl crossing the shop tracks nearby, and at the same time he noticed an empty box car silently coming down the same

He Noticed an Empty Box Car Coming Silently Down the Tracks

track, unnoticed by the girl. In a flash he realized that a car with a broken coupler had parted from the switching train and, rolling down the slight incline, had almost reached the unsuspecting girl. Like a shot he jumped, picked her up unceremoniously and deposited her on safe ground. In her surprise the girl struck out and cut a long gash across his forehead with the edge of her handbag, but did not utter a sound. There they stood now, staring at one another—Sidney speechless with embarrassment at having dared to pick up and rough-handle this wonder of womanhood. Small and shapely, a pretty head within a glory of gold-tinted hair and a pair of eyes that seemed to search his soul, she appeared to him, with his limited knowledge of refined womanhood, the very embodiment of an angel from heaven.

Now the shadow of the passing car fell on her and, turning about, she quickly realized what this man had done for her. She turned pale at the thought of the fate she had just escaped and, turning again to thank her rescuer, she looked into a face so comical with smears of blood, dirt and embarrassment that she broke out into a silvery laugh. Quickly recovering herself, she thanked him for what he had done in such an open-hearted way that Sidney quickly found his poise again. He waived aside all thanks, explaining how the car happened to be loose.

"It's that old fool of a foreman's fault," he said. "He is

She Suddenly Appeared In Front of Him on the Street

directing the switching and should have watched out for this car."

"No," said the young woman, "it was my fault for trusting so much to the blue flag, laying there now under the car, and not keeping a watchful eye on all tracks, as my dad,, who happens to be that 'old fool of a foreman,' has taught me."

With that she laughed her silvery laugh again and was gone before Sidney recovered himself.

Returning to his work, he was glad that no one seemed to have seen his encounter, but he was quiet and like one stunned. Never in all his life had a woman affected him like this. He told himself that it must be because he had never come into close contact with any real lady before, but at the same time he knew that he had, without a second's notice, fallen hopelessly in love with Ellen Goodell, his foreman's daughter.

He did not see her again until two weeks later, when she suddenly appeared in front of him in the street and stopped him with outstretched hand and a hearty greeting. Obviously admiring his gentlemanly looks in his street clothes, she soon put him at ease with her merry talk, and before he knew how it had happened he had accepted her invitation to call on her at her home. There he learned that she had lost her mother and was her father's only companion and housekeeper.

Her father paid no attention to him, merely saying a gruff "Good evening" when he passed through the room, while

Ellen told Sidney not to pay any attention to this; that her father was a dear old bear with all his grumpiness.

Both being honest and open-hearted, Sidney and Ellen soon exchanged experiences and confidences like old friends, but Sidney could not overcome the feeling that this lovely girl, judging from her talk, belonged to a different sphere socially, even if his democratic spirit would never admit that about her father. Yet when he studied her father's ways and those of the other foremen about the shops he could not but see that they tried to surround themselves with a spirit of social superiority that was greatly distasteful to his democratic nature.

Meantime the war advanced, conditions all about changed continually, the men grew restive and nervous, being harrassed continually by their union leaders, the advancing cost of living, continued calls for war relief contributions and war bonds. Argument and gossip filled up their time and production lagged more and more. The Railroad Administration, needing cars badly, tried in every way, from stirring the men's patriotism to bringing pressure on them through their foremen, to increase the output, without great results. Many inexperienced men were put to work, the foremen grew harsher and the men more nervous. Cursing and ugly brawls became more common every day.

Sidney, in his sincere desire to do right, worked harder than ever, but only earned sneers from the men and a contemptible smile from his superiors for trying to outdo the rest of the gang. Small controversies with members of the supervising force, when he tried obstinately to uphold what he thought right, only made more enemies for him. The gang foreman who checked his work was an old employee, who prided himself on his great knowledge and on his unimpeachable honesty towards the company in the smallest details. In checking a car for Sidney he questioned the weight and size given by him for a certain iron on the car, and launched into an argument that included the foreman, Sidney, his partner Ben, and two laborers.

Sidney, getting tired of it all, suddenly asked the gang foreman where all his great honesty towards the company came in when the possible difference in the weight of the iron would amount to not more than two cents, while here between the six of them they had already wasted over two dollars' worth of the company's time and had accomplished nothing.

Incidents of this sort being of daily occurrence, Sidney grew more and more dissatisfied with his surroundings. His friendship with Ellen had grown meanwhile into a deep and adoring love on his side, and Ellen herself felt more deeply for him than she would admit to herself.

There seemed to be always some barrier between them which kept them from going out in public together or to mingle in the same sets socially. He saw her alone only at her home, and she would often try then to induce him to give up his present work and take what Sidney called "a white shirt and collar" job. He treated these attempts of Ellen's lightly, but could not overcome a slight feeling of unpleasantness over these trials.

One day, after an exceptionally unpleasant argument with his foreman, who tried to impress him with his superiority when Sidney knew himself to be in the right, he carried his shop troubles into his conversation with Ellen. An argument resulted, which grew to fever heat when Sidney denounced her father's ways and actions, Ellen taking her father's side uncompromisingly. Forgetting all caution, she claimed that her father and she stood so high above an ordinary car knocker that they would lower themselves by yielding an argument to him and that he had better try to get into some more gentlemanly position or else let her alone. In a rage Sidney grabbed his hat, left without a word, and the next day had abandoned his job and the town. He volunteered for the army, was accepted, and before long was at the front in France as a car repairer with the railroad forces, where events did not leave him much time to think over his shop experiences.

Twenty months later, when discharged at last and looking about for work, Sidney was given mileage to his place of recruiting, and so happened to return again to the town of his former labors. Seeing the old place once more awoke many recollections, and almost unconsciously he left the train, to begin where he left off. There was a crowd of people at the depot looking for returning soldier boys, and he was at once hailed by many old acquaintances.

Suddenly his heart stood still as he thought, there in the crowd away back, he saw Ellen Goodell, pale and thin, dressed in black, looking at him in a far-off, strange way. His first impulse was to run and embrace her; he had never forgotten her for a moment in all their time of separation. Noting that she made no move, but stood as if frozen to the spot, the recollection of their parting came over him suddenly, and he turned about and walked off without a sign of recognition.

Calling at the car shops the next day, Sidney found many of his former co-workers and was most cordially received by all, until he ran into his old partner Ben, who received him

There In the Crowd, Away Back, He Saw Ellen Goodell

enthusiastically and urged him at once to come back to work with him, saying that since he was an ex-soldier he was assured of a job.

"Yes," said Sidney, "but what about my old friend Goodell; do you think he will take me back?"

"Well," answered Ben, "the old man died of the 'flu' eight months ago and things have been turned inside out around this yard since then. You'll sure like it here now. There is our new foreman, Mr. Woods; go and jump him right now, get your job and come back and I'll tell you all about it."

Sidney approached the man pointed out, a slight but wiry and alert man, slightly gray and with a pleasant, open face. No sooner had he stated that he was an old member of the force and looking for work than the foreman took his hand, congratulated him on his safe return and told him to go back to his job just as soon as he wished to start again. Then he engaged him in some pleasant conversation about his war experiences, but Sidney noted that whenever one of the men approached with a question or request he would stop at once, attend to the man in a short, precise manner, but with a smile on his face, before going back to his conversation with him. When released, Sidney hurried back to Ben and voiced his surprise at the cordial reception he had received.

"Now you are talking," said Ben, "but, oh, boy, you have not half found out yet all the change in this old place. You remember how we used to peg along here with poor equip-

ment and tools, short material to work with, no encouragement from the bosses, petty jealousies among the men and union squabbles. Well, it kept on that way from bad to worse, with production falling off more and more, old man Goodell getting more crabby, and the old office fossils more cantankerous all the time, until the master mechanic got peeved, came over and blessed out the whole outfit and looked about to see where more steam was needed. First thing he sent over a young woman as clerk in the office. Now, wouldn't that jar you—a woman in this car shop? We sure didn't know what to make of it at first, but that girl, with her smile for everybody and prompt and ready answer to every question we had to ask in the office, soon had us all going her way. First thing, the boys marked a line a hundred yards around the office and let every man on the force know that it would not be good for his health to be heard using bad language inside that circle. Soon the boys got so in the habit of minding their tongues that you hardly ever hear them cuss anywhere now. Only that old fossil in the office gets a fit sometimes when that girl goes to work and changes things about, but that don't worry her any. Now they can put their hands on any record there in a minute, while before they always had to hunt all over to find anything.

"Next thing old man Goodell came down with the 'flu' and died, after a long hard struggle. Our men and their wives went there and did all they could, and Miss Ellen, who seemed not to like their coming at first, later realized what good friends our people were to her, and she has stuck to them ever since. She makes her living now working in an office downtown, since the old man didn't leave her anything, and mighty sad and lonely she looks, too.

"Next comes this here new foreman walking in on us one fine morning, and the old man in the office gives up to a new man who used to be in business and runs the whole office like a business, too. Well, every blessed morning since he came the foreman has found time to go all over the shop yard and give a pleasant 'Good morning' and cheery word to everyone of us, but his eye goes flying around and he sees everything that's going on. If anyone has a request he listens and gives a prompt answer, and I often see him do three things at one and the same time, like talking to the big boss, answering questions for his men, signing papers, all with the same smile, and yet nothing escapes his eye that's going on around the yard. He may not know as much about car repairing as old man Goodell did, but then he'll accept a suggestion from us old-timers anyway and even ask our opinion of how some things should be done. He is on to every man here and how to handle him — to get the most work out of him, which seems to be his pet study.

"See those two Italians over there? They used to be about the slowest team on this ranch. Some time ago they had a heavy repair job on a coal car and didn't make any headway at all with it at first. What do you think he does? Cuss them? Not on your life. He just gives them a little talk on the coal shortage misery every day as he goes by, until those fellows got so interested that they felt they made a lot of poor women and kids up north suffer just so much longer for want of that old car to move coal. First thing they worked like blazes to get rid of the car, and they were proud as peacocks when she rolled out of the yard. That's the way he'll get us all interested in whatever we do; he always has something to tell you that stirs you up somehow. He'll talk about tools or metal or merchandise or anything, and he has those coach workers so interested they lose sleep sometimes thinking over their jobs. He got them impressed by degrees with how much damage a poor job of theirs can do to a crowd of passengers, so they always feel as if they are responsible for the lives of the people that travel in their cars.

"Besides making us look differently at the work we are doing, all the boys are in the habit now of going to him with our personal troubles and there's nothing so small that he won't have a kind word of advice for. If it's anything about our time or some writing to be done, he sends them to his office and the clerks there are always willing and ready to listen and do what they can. The boss never wants to hear anybody say about anything, 'I haven't got time.' You can go to his office with a little scratch on your hand or any kind of hurt and they'll drop everything else and clean and bandage you. But let any fellow try to tell him a tale about some one—he'll make him prove it or eat it, and he'll fight at the drop of a hat if he sees any crooked things going on.

"We did have some underhand agitators around here that tried to stir up a little trouble, but they quit and left the country as soon as the boys caught on to their works. It didn't seem healthy around here for them. Now you know why we all like to come to work here in the morning."

Sidney soon became familiar with the new conditions and worked with a new enthusiasm, seeing his dreams of working conditions coming more true all about him. He received another surprise at the first meeting of their local union

Sidney Simply Picked Her Up and Held Her to His Heart

which he attended. Formerly the men, in their unofficial debates after the business meeting, talked about nothing but grievances, sport, drink and so forth; now the conversation was almost entirely about their work. With wonder he was told that there was a monthly production contest going on between their shop and the nearest one on the system. It was altogether unofficial, but the clerks in both offices were gladly working overtime to supply the data, which were figured out somewhat after the old piecework schedule. Interest in the outcome was intense, resulting in increased production at both shops. The foremen on both sides never interfered, he was told, except to see that only good work left the shops.

Sidney's intelligent and honest work was quickly recognized by the new foreman, who often stopped to talk to him briefly, feeling him out on different topics, until one day he asked Sidney to a social gathering to be held at his home that evening. He explained that this was an altogether informal gathering of men and women interested in their line of work and said that these little socials often gave them all much help by giving them an opportunity to talk over

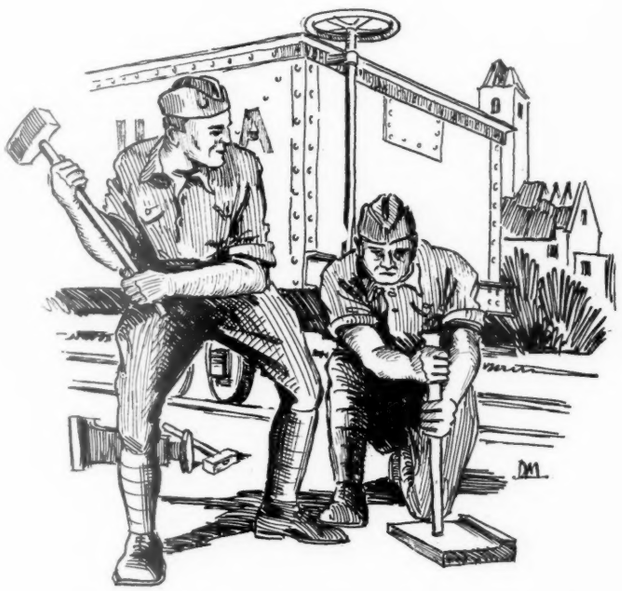
matters that they had not time enough for during working hours.

Sidney welcomed the diversion. Ben's recital of Ellen's troubles had touched him deeply; he loved her still, but was afraid to meet her, not knowing how she would receive him and still yearning to go to her to comfort and protect her.

At the foreman's house he was received like an old friend by Mrs. Woods and her daughter. He found a number of the shopmen and some of their wives, so that he felt quite at home at once.

Still other guests were arriving when Miss Woods asked him to come with her to meet her dearest friend, who was helping to prepare some refreshments for them all. Following her into another room he noticed a young woman with her back turned to him. When he approached she turned about, and then Sidney found himself looking straight into the eyes of Ellen Goodell. His heart jumped at the message those eyes held for him, when Ellen held out both hands to him and in a low voice said, "Sidney, can you forgive me? I have since found out what happiness it gives to serve, and that in service we are all equals."

Stunned by the suddenness of it all, Sidney simply picked



And How this Ever Revived Them and Spurred Them to Renewed Effort

her up and held her to his heart. After an interval of blissful forgetfulness of all his surroundings, he said, "Child, I'll never leave you again, but our squabble was too serious; it can only be patched up by a preacher, and he'll have to act pretty soon at that." To this Ellen readily consented and sealed the agreement with a kiss.

Guiltily looking around, they found themselves all alone in the room. Joining the company again they were greeted with congratulations and laughter.

"Well, said Mr. Woods, "talk about a rapid fire, you two sure get the prize, from the looks on your faces. Here my wife and girl framed this meeting carefully, to get you two together again by degrees, and you take the whole works by storm at the first shot. You must have learned that in the war."

After the pleasant excitement over this happy solution of the lovers' quarrel had subsided, Mr. Woods skillfully led Sidney to recite some of his experiences as car repairer at the front in France. As he warmed up to his subject and his recollection of incidents came back, he became eloquent in his enthusiasm, and the whole assembly was listening in breathless concern to his narrative. He told how many a time they had realized that thousands of lives of their brave boys in the war front had depended on the despatch of a train of munitions or food, and how he and his companions had worked to utter exhaustion to get the damaged rolling stock in condition again. How under gruelling shellfire and unspeakable conditions of filth, mud and hunger, as men standing next to him were blown into eternity; when despair of being able to go on further had turned into abject fear and horror and he had felt ready to lay down right then and give up, their lieutenant, with the eternal cigarette between his smiling lips, would turn up and simply tell them not to forget, that they were only allowed to stay back there in comparative safety and comfort so that they could serve those gallant boys up ahead, who had to get along in a living hell to fulfill their duty, and how this ever revived them and spurred them to renewed effort.

"That was the time," Sidney said, "that I realized fully and forever, that the laborer's real pay is not in his envelope, but in his service to his fellow man."

"There, friends," broke in Mr. Woods, "is the keynote of success for all workers alike. Service to the good of humanity. They say that corporations have no soul, but I say, that from the same point of view the great mass of our unions, supervisory officers and workingmen have the same lack of soul and only when all parties concerned will go out to hunt for and recognize the other fellow's soul, will there be real harmony and better times for all.

"I firmly believe that the American workingman has too active a mind and too broad a conception of life, not eventually to find his way out of all the present misconceptions and troubles, into this line of thought. So let us all hope and put forth our individual efforts in the great task of smoothing the path between employer and employee, with the thought of service to mankind ever before us."

A NEW LUBRICANT.—A new fruit containing a large percentage of oil has been discovered in the region of Torreon, Mexico, and is known by the name of chichopoxtle. Experiments show that 25 per cent of its contents consists of oil of great value in industrial pursuits requiring a lubricant of high quality. It is proposed to introduce the cultivation of this fruit on a large scale.—*Railroad Men.*

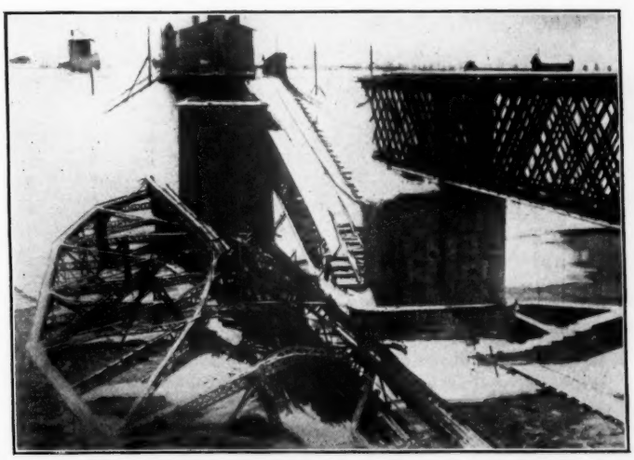


Photo from Underwood & Underwood, N. Y.

Railway Bridge at Narva, Esthonia, Destroyed in Campaigns Against Bolsheviki

STANDARD MOTION WORK AIDS VALVE SETTER

Fundamental Valve Gear Dimensions Are Carefully Checked With the Blue Print at West Albany

BY J. McALLISTER
General Foreman, West Albany Shop, New York Central

THE work of setting valves on a heavy repair locomotive is greatly simplified and reduced when the important dimensions of each valve gear part are made to check with the blue print before that part goes to the erecting shop for assembly. This careful checking of dimensions is made necessary by two conditions. First, the builders are not infallible, and occasionally a mistake is found in a practically new locomotive valve gear. For example, the distance between the steam edge of the back port and the center of the link trunnion of a locomotive equipped with a Walschaert gear was recently found to be 5/8 in. longer on one side than on the other.

The second reason for checking dimensions is that valve setters often make slight alterations when squaring a valve, and by the time a locomotive has had three or four general repairs there may be serious differences between the actual valve gear dimensions and those called for by the blue print. As an example of the latter case, the practice of making valve adjustments by upsetting or lengthening the radius bar may be mentioned. This results in a radius bar that does not correspond in length with the link radius and introduces irregularities into the valve motion. Sometimes the distances between pin centers of the combination lever are not in the right proportion, or the lead is not properly equalized by the union link. Perhaps the right-hand valve stem is longer than the left or the valve chamber bushings are too near together.

A valve gear may be completely overhauled and all worn parts renewed, but if the above-mentioned discrepancies are not noted and corrected in the machine shop they will have to be corrected by the valve setter, who does not discover them until all the motion work has been connected up. This involves taking down at least part of the motion work again, and very often results in a delay to the locomotive. Obviously the best way is to check all motion work carefully in the machine shop and, as far as possible, make it correspond exactly with the blue print.

Method of Handling Motion Work

While it is not claimed that any new method of setting valves has been developed at West Albany, the following system of handling motion work through the shops has made valve setting a comparatively simple operation which requires only a minimum of time.

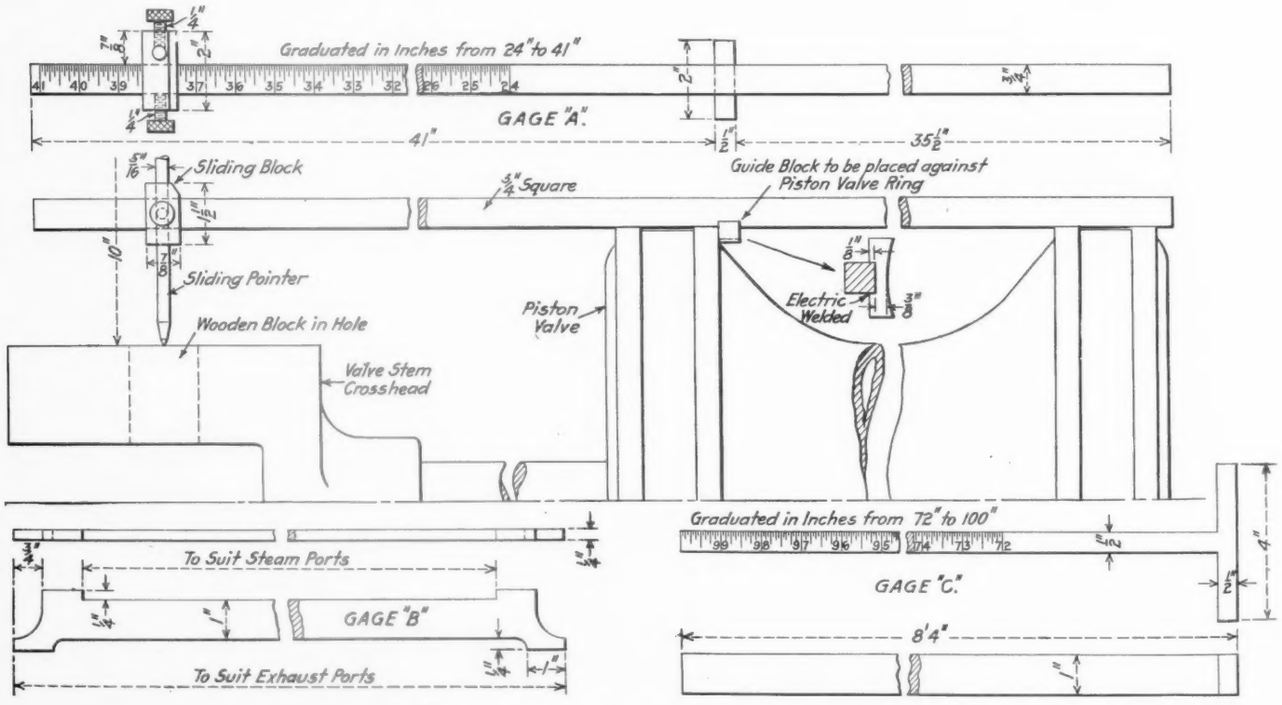
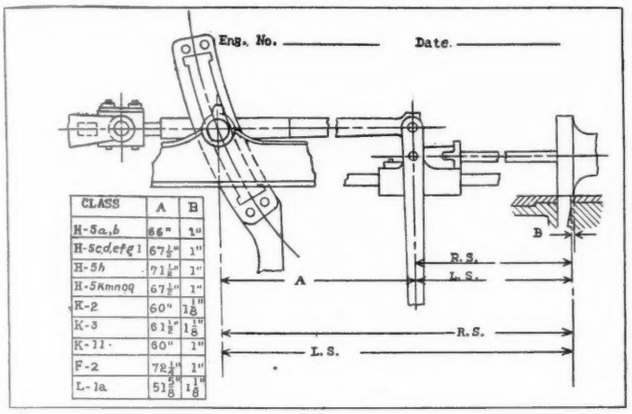


Fig. 1. Gages Used in Checking Valve Gear Dimensions at the West Albany Shops

All locomotives shopped for classified repairs have the valves and motion work removed and sent to the machine shop. Exact measurements are taken with gage *C*, Fig. 1, of the distance from the steam edge of the back port to the center of the link trunnion on each side of the locomotive. This distance is marked on valve setting Form No. 1, which is then delivered to the machine shop foreman. The valve chamber bushings are calipered and gaged, using gage *B*. The bushings must gage properly, and if they do not, new ones are applied and bored out. If found to be out of round and not below the limit of thickness, the bushings are bored.

All parts of the motion work are dismantled and new hardened bushings and pins are applied where necessary. All worn parts are built up by autogenous welding and

machined to the standard size. The radius bars are trammed for length, using standard stationary trammels made to conform to the true radius of the links. If not of the proper length, the radius bars are sent to the blacksmith shop for correction. The combination levers are lined up on a surface table and measured for the proper distances between pin centers. If they are found not according to the blue print, corrections are made. The links are ground to the proper radius. The link blocks are built up by autogenous welding and refitted. Trunnion plates are applied, the holes

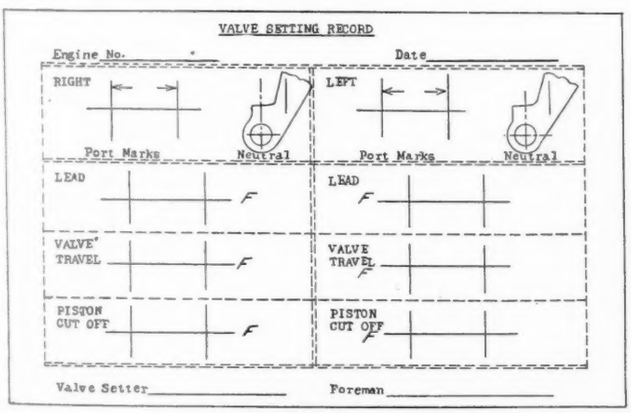


CLASS	A	B
H-5a,b	66"	1"
H-5c,d,e,f,g	67½"	1"
H-5h	71½"	1"
H-5kmnoq	67½"	1"
K-2	60"	1⅛"
K-3	61½"	1⅛"
K-11	60"	1"
F-2	78½"	1"
L-1a	51⅝"	1⅛"

Valve Setting Form No. 1

being reamed and new bolts fitted. If the trunnion centers do not check with the link centers, new trunnion centers are turned and bushings applied.

The valves are dismantled, the valve stems are ground or renewed as necessary and fitted to the valve crosshead. New packing rings are properly fitted to the bushings. The valves are then assembled and measurements taken from the center of the combination lever pin hole in the valve crosshead to the edge of the back steam ring, using gage *A*. This distance, plus the length of the radius bar, must equal the meas-



Valve Setting Form No. 2

urements marked on Form No. 1, plus the lap of the valve. Parts are delivered to the erecting floors ready for assembling.

Method of Setting Valves

The motion work is assembled on the locomotive, the valves put in and port marks scratched on the valve stems. The reverse lever is placed in the central position and the link blocks lined up or down to get a dead valve on both sides. The combination lever is plumbed. If the work has been done properly the valves will be neutral. The union links are connected up, the locomotives placed on centers and the lead marked on the valve stems. If the lead is not properly equalized, alterations are made in the union link.

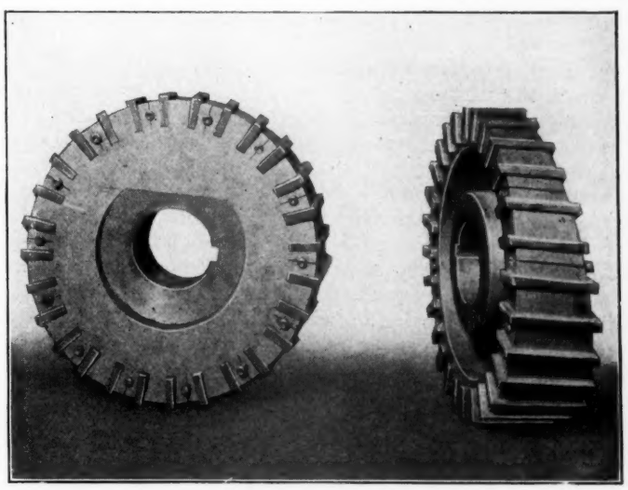
The locomotive is now placed on the centers in full gear forward and back. The eccentric crank is trammed for the neutral position, the lead marked aand adjustments made in the eccentric rod if necessary. The engine is run over, with the reverse lever hooked up to adjust the cut-off to 25 per cent for passenger locomotives and 30 per cent for freight locomotives. The lead, valve travel and piston cut-off are taken in both forward and back motion. Adjustments are made to equalize the piston cut-off, a greater variation than one-half inch not being permitted. The necessary offsets for crank arm keys is measured.

Before removing the crank arms to apply the rods, they must be gaged with the usual form of crank gage supplied for that purpose and readings taken. When reapplied and permanently keyed, the crank arms must check with the readings. Valve setting Forms No. 1 and No. 2, after being filled out, are kept as a permanent record.

As previously indicated, the above method of making motion work repairs and setting valves has worked out well, and the results have amply repaid all additional care and attention given this matter. Locomotives are no longer delayed by mistakes in the valve gear discovered at the last minute; no time is wasted "squaring values" after the locomotive has had a trial run; a good valve gear is assured, which sounds square, has an equalized cut-off and gives a good distribution of steam.

ADJUSTABLE MILLING CUTTERS

There are many places where milling cutters which are adjustable in width can be used to advantage. The ordinary types of adjustable cutters, however, are not satisfactory because the width can only be adjusted slightly less than twice the overhang of the blade. An interesting design of adjustable cutters in use at the Dale street shop of the Great Northern is shown in the illustration below. The cutters are used in pairs. The body of each has one side perpendicular to



Milling Cutters With a Wide Range of Adjustment

the axis, while the other side is cut out at a small angle to it. The key ways are located so that when placed on the arbor the narrow part of one cutter is adjacent to the wide side of the other. By placing rings between the two parts, the width of the cut can be varied by an amount equal to the difference between the length of the longest and the shortest blade. As the total length of the cutters which are in operation remains the same at all times, there is no change in the torque on the arbor and no tendency to chatter. This arrangement has been found useful for cutting out shoes and wedges, crosshead shoes and similar parts.

RAILROADS FAIL BADLY IN TRAINING SHOPMEN

Mechanical Department of Railroad Administration Compiles Statistics as to Number of Apprentices

ALMOST fifteen years ago George M. Basford, then editor of the American Engineer and Railroad Journal, made his memorable address before the American Railway Master Mechanics' Association, in which he pointed out the vital necessity on the part of the railroads of giving immediate attention to the selection, preparation and training of men for railroad service. The American Engineer and Railroad Journal and its successor, the *Railway Mechanical Engineer,* have consistently emphasized Mr. Basford's recommendations, in season and out of season, for all these years.

What has been the net result, so far as the mechanical departments of our railroads are concerned? We are ashamed to have to admit that very little has been accomplished. Whether it be because Mr. Basford was too far ahead of his time, whether because of lack of ability on the part of Mr. Basford's followers and the technical press in presenting the matter to the railroads, whether it be a lack of vision and executive ability on the part of the railroad managers, or whether it be a combination of all of these things, the results in the railroad field have been truly disappointing. Men in other industries have been quicker to adopt Mr. Basford's suggestions and, directly or indirectly, his suggestions have had a big influence on the development of the National Association of Corporation Schools and the speeding up of apprentice training in the industrial field.

No one has accused the mechanical department of the Railroad Administration of being wildly enthusiastic about the extension of apprentice training. Why should it be? If when the Railroad Administration took over the control of the railroads it had had behind it 10 or 12 years of real apprentice training its task would have been much easier. The railroads had never given the matter any serious attention (except in a few isolated spots); why should it do so? Moreover, the most ardent advocates of the proper selection, preparation and training of employees are not foolish enough to promise immediate results—and immediate results were what the Railroad Administration had to have.

In spite of this, however, Mr. McManamy has compiled complete data as to the number of workmen, helpers and apprentices in each craft on all the roads under federol control. This data is given in full in the accompanying tables. It does not give us any particular pleasure to publish it. We dislike to have to show up a condition which, to say the least, does not reflect any credit upon the railroad mechanical departments of the United States. We pride ourselves on leading the world with our wonderful railroads and our efficient methods. It is too bad that we do not compare more favorably with foreign roads when it comes to the selection, preparation and training of employees. It is strange that we have so little appreciation of the importance of the human factor in our railroad operations.

The figures as to the number of apprentices of course tell only part of the story, bad as it is. If as concrete a picture could be presented of the methods of instruction of apprentices on the different roads, the shock would be still greater. A few—a very few—roads have gone at the problem in a big way, but the great majority have just played with the task and have hardly touched the edges of the job.

Organized labor has the reputation of keeping down the percentage of apprentices. Has it? It seems more than passing strange that those sections of the country where shop labor was so highly organized in pre-war days should show up so well in comparison with other sections. It surely looks as if the railroad shop managements should be held to their accountability in restricting the number of apprentices. If the figures as to machinist apprentices do not bother you, run your eyes along the line to the other crafts. Do not hurriedly jump over the carmen.

But why comment further? The figures tell the dismal story plainly enough. If the Interstate Commerce Commission or some other governmental agency should step in and take a hand in the matter by ordering improvements to be made there would be an awful howl—but what are the railroads doing to make good?

In June, 1905, Mr. Basford closed his address with these words: "Are we a nation so enveloped in a cloak of progress that we cannot see the future?" Since 1905 hundreds of our big industrial companies have met this challenge by inaugurating modern up-to-date methods for training their men. Ought we not today ask this question: "Are the railroads of the United States so sound asleep as to the importance of training and developing the human factor that they will fail to make good in the future?"

* * *

Assume for a moment that the railroads generally did awaken to their full responsibilities and really did inaugurate modern up-to-date apprentice systems, would that be sufficient? No! To make these measures fully effective—and we, of course, assume that they would be accompanied by steps to insure the proper selection of boys and young men—it will be necessary to take measures to study critically the disposition, ability and performance of each individual in the organization so that the men may be assigned to those tasks for which they are best fitted and in order that promotions may be made intelligently and in the best interests of the organization as a whole.

We subject the most ordinary materials that we use on railroads to all sorts of tests, even resorting to the compound microscope and to micro-photographs. But what about the most vital factor in railroad or industrial organization—the human factor? Why is John Smith assigned to lathe work? Is it because he is better fitted for that particular work than for other tasks, or is it purely accidental? Why was Bill Jones made gang boss or foreman? Is it because he had been subjected to critical study over an extended period, or is it because he happened to be in favor, or particularly prominent, at the time the appointment was made?

If the wrong man is promoted how much damage is done? In the ranks Bill Jones was an individual. As a foreman his inefficiency may be multiplied by the number of men under his direction. Moreover, other men, realizing that he is a misfit, feel that merit is not recognized and lose any ambition to strive to so perfect themselves as to be available for promotion. They reason that the chances of being hit by promotion by "the hit and miss" method of selection are about the same as being hit by lightning. Because promotions are not made by scientific, accurate means and because no standards of measurement are set, they lose interest or, if they do believe in lightning rods, take such peculiar measures as they think will give the best results in attracting the attention of that peculiar and uncertain element.

It is too bad, for the solution of these difficulties is so simple and easy, and so well worth while, if we would only awaken to the seriousness of the situation.

TABLE I—MECHANICS, HELPERS AND APPRENTICES IN ALL DEPARTMENTS, BY CRAFTS. EASTERN REGION.

Railroad	Machinists			Boilermakers			Blacksmiths			Sheet Metal Workers			Electrical Workers			Carmen			Moulders			Other Mechanics			Grand Totals
	Machinists	Helpers	Apprentices	Boilermakers	Helpers	Apprentices	Blacksmiths	Helpers	Apprentices	Sheet Metal Workers	Helpers	Apprentices	Electrical Workers	Helpers	Apprentices	Carmen	Helpers	Apprentices	Moulders	Helpers	Apprentices	Other Mechanics	Helpers	Apprentices	
Ann Arbor	39	22	8	17	15	1	8	9	1	2	1	..	9	..	..	60	6	..	..	..	..	48	10	..	256
Bangor & Aroostook	70	48	7	17	15	..	13	11	..	4	2	1	3	1	1	198	11	..	1	..	..	..	..	..	403
Boston & Albany	367	221	54	77	100	14	56	52	4	21	10	6	121	49	..	421	208	11	..	..	..	200	723	94	2,809
Boston & Maine	1,015	679	93	255	268	6	165	175	4	108	52	..	78	19	1	2,170	132	21	..	..	..	350	242	..	5,833
Buffalo, Rochester & Pittsburgh	324	225	65	120	55	7	46	38	2	61	16	3	77	34	..	724	70	4	1	..	..	..	..	..	1,872
Central New England	47	42	..	18	15	..	7	8	..	3	2	..	4	..	..	218	3	..	..	..	..	111	19	..	477
Central Vermont	166	43	18	55	30	9	23	10	3	13	2	2	8	..	..	198	10	2	10	3	1	52	..	..	658
Chicago & Erie	141	98	35	67	38	12	21	17	3	29	12	4	34	21	..	380	38	..	..	..	..	..	..	..	950
Chicago, Ind. & Louisville	175	124	28	76	104	15	25	29	..	28	14	4	11	5	..	350	45	..	1	2	..	37	8	..	1,081
Cincinnati, Ind. & Western	69	57	13	42	41	4	11	15	2	10	9	2	12	8	..	136	26	11	2	..	..	7	21	..	498
Cincinnati Northern	34	39	5	26	22	..	6	8	..	7	2	..	3	..	..	72	19	1	..	..	..	5	..	..	249
C., C., C. & St. Louis	779	455	140	261	174	24	154	164	11	105	46	11	334	78	4	2,415	176	54	..	..	..	30	..	..	5,415
Delaware & Hudson	762	444	101	210	129	24	102	102	1	62	28	2	137	17	4	1,608	98	17	36	3	..	231	39	1	4,160
Delaware, Lack. & Western	913	588	162	273	211	36	132	136	11	232	86	4	270	128	5	1,805	218	12	71	12	8	314	145	1	5,773
Detroit & Mackinac	23	16	5	5	7	1	7	6	..	3	..	..	..	..	..	55	..	..	..	..	..	14	4	..	146
Detroit & Toledo Shore Line	10	8	1	6	4	1	2	1	..	1	1	..	..	..	..	32	3	..	..	..	..	14	..	..	84
Erie	1,844	1,329	326	576	323	70	252	241	15	392	138	16	367	226	13	2,941	442	16	31	..	4	86	7	..	9,655
Grand Trunk Western	353	150	58	72	65	9	88	62	2	84	22	1	137	26	15	1,172	56	4	2	..	..	760	..	..	3,138
Detroit, Toledo & Ironton	55	23	18	25	24	1	11	11	..	9	1	..	10	1	..	144	21	..	..	..	..	27	2	1	384
Grand Trunk in New England	54	38	26	10	16	..	10	12	..	7	..	..	9	5	..	80	1	23	2	1	..	83	33	2	412
Hocking Valley	162	108	21	66	66	9	33	39	1	53	28	3	18	1	1	582	70	2	4	4	..	98	32	..	1,401
Kanawha & Michigan	48	38	8	22	24	2	13	17	..	5	3	1	2	1	..	228	84	..	1	..	..	40	6	1	544
Lake Erie & Western	104	113	20	59	65	5	19	24	2	13	4	..	48	37	..	219	27	..	2	1	..	192	23	3	980
Lehigh & Hudson River	32	29	20	7	12	6	5	5	1	2	1	..	9	5	..	58	3	..	..	..	..	4	1	..	202
Lehigh & New England	73	30	12	16	23	1	6	6	..	9	4	1	12	4	..	64	1	3	..	..	..	17	29	..	311
Lehigh Valley	1,208	687	174	346	236	26	148	171	11	171	76	7	364	99	10	2,042	279	21	2	1	..	357	85	..	6,521
Maine Central	230	144	15	53	53	..	45	47	..	23	5	..	51	40	..	926	82	3	..	..	..	9	2	..	1,728
Michigan Central	676	364	85	233	187	7	124	93	2	99	50	..	225	94	2	2,350	247	..	3	2	..	290	315	2	5,450
Monongahela	17	16	..	8	7	..	1	1	..	..	..	..	2	1	..	88	..	..	..	..	..	..	..	8	149
New York Central	2,784	1,803	357	1,082	790	40	495	497	13	660	270	19	1,349	335	127	10,544	1,215	60	72	85	2	1,068	411	1	24,079
New York, Chicago & St. Louis	194	133	32	88	96	8	29	38	..	13	9	1	19	..	..	656	53	..	2	1	..	369	63	..	1,794
New York, New Haven & Hartford	1,282	944	141	292	284	24	163	191	4	273	169	2	422	183	22	2,301	249	11	..	..	..	1,105	266	7	8,335
New York, Ontario & Western	161	132	24	45	45	4	29	35	..	16	3	..	57	16	..	385	81	13	..	..	..	31	12	..	1,089
New York, Susquehanna & Western	71	24	14	18	8	2	10	4	..	9	2	..	15	3	..	58	8	..	..	..	..	..	..	..	246
Pere Marquette	448	251	77	205	158	7	59	75	1	69	33	..	71	10	1	907	202	8	..	..	..	658	13	..	3,253
Pittsburgh & Lake Erie	317	266	52	77	70	..	39	37	..	53	12	..	138	23	..	1,792	247	..	..	..	..	63	256	..	3,442
Pittsburgh & Shawmut	33	17	..	7	6	..	4	3	..	2	..	..	1	..	..	24	1	..	..	..	..	..	..	..	98
Pittsburgh & West Virginia	37	27	3	13	13	4	6	7	1	..	..	..	10	3	..	97	..	..	..	..	..	18	1	..	240
Rutland	66	61	10	16	14	..	11	14	..	8	3	1	3	1	1	173	13	2	1	1	..	59	..	..	458
Toledo & Ohio Central	152	110	21	77	45	1	26	20	..	21	4	1	48	14	..	416	59	4	..	..	..	4	..	..	1,023
Toledo, St. Louis & Western	66	87	32	34	51	4	14	21	..	16	2	..	8	2	1	216	102	1	1	5	1	92	32	..	788
Ulster & Delaware	14	7	8	6	2	4	2	2	..	1	..	..	7	1	..	23	2	1	..	..	..	2	9	..	91
Wabash	687	554	97	200	226	25	117	145	11	148	79	25	74	9	3	1,260	223	8	5	2	..	..	..	..	3,898
Wheeling & Lake Erie	200	95	35	72	101	8	27	36	1	28	3	5	32	3	..	518	132	1	4	..	..	113	56	1	1,471
	16,302	10,635	2,421	5,250	4,238	421	2,564	2,635	107	2,873	1,204	122	4,609	1,505	211	41,106	4,965	314	254	123	16	6,948	2,865	122	111,864
Ratio	....	1.5	6.7	....	1.2	12.4	....	.9	24.0	....	2.4	23.5	....	3.0	21.8	....	8.2	130.8	....	2.0	15.9	....	2.4	56.9	.....

TABLE II—MECHANICS, HELPERS, AND APPRENTICES IN ALL DEPARTMENTS BY CRAFTS. ALLEGHENY REGION.

Railroad	Machinists			Boilermakers			Blacksmiths			Sheet Metal Workers			Electrical Workers			Carmen			Moulders			Other Mechanics			Grand Totals
	Machinists	Helpers	Apprentices	Boilermakers	Helpers	Apprentices	Blacksmiths	Helpers	Apprentices	Sheet Metal Workers	Helpers	Apprentices	Electrical Workers	Helpers	Apprentices	Carmen	Helpers	Apprentices	Moulders	Helpers	Apprentices	Other Mechanics	Helpers	Apprentices	
Atlantic City	22	11	1	7	5	..	4	2	..	1	..	..	6	6	..	50	..	..	..	..	..	30	4	..	149
Baltimore, Chesapeake & Atlantic	5	6	..	3	4	..	1	1	..	..	..	..	1	..	..	..	..	..	..	..	..	3	..	..	24
Baltimore & Ohio Lines, West	1,214	889	177	516	571	54	168	196	7	232	107	26	143	56	3	2,583	223	12	27	35	2	465	95	3	7,804
Baltimore & Ohio Lines, East	1,795	1,242	274	631	554	17	230	220	4	320	188	7	294	130	110	3,793	600	12	49	64	1	2,852	274	4	13,165
Bessemer & Lake Erie	227	174	2	66	50	..	29	25	..	17	6	..	31	5	..	649	49	..	2	1	..	1	..	..	1,334
Buffalo & Susquehanna	39	23	7	13	10	3	8	12	2	4	3	1	..	..	..	108	65	5	1	1	..	..	..	..	305
Central Railroad of New Jersey	614	435	82	204	179	14	87	122	2	96	64	..	168	41	9	1,649	461	10	..	..	..	294	23	..	4,289

TABLE II—MECHANICS, HELPERS AND APPRENTICES IN ALL DEPARTMENTS, BY CRAFTS—ALLEGHENY REGION—*Continued*

Railroad	Machinists			Boilermakers			Blacksmiths			Sheet Metal Workers			Electrical Workers			Carmen			Moulders			Other Mechanics			Grand Totals
	Machinists	Helpers	Apprentices	Boilermakers	Helpers	Apprentices	Blacksmiths	Helpers	Apprentices	Sheet Metal Workers	Helpers	Apprentices	Electrical Workers	Helpers	Apprentices	Carmen	Helpers	Apprentices	Moulders	Helpers	Apprentices	Other Mechanics	Helpers	Apprentices	
Coal & Coke	21	24	5	7	10	2	7	6	..	5	3	..	6	..	..	82	9	..	..	..	..	4	..	..	191
Grand Rapids & Indiana	128	28	15	29	21	4	15	16	..	30	2	..	13	2	1	230	33	4	1	1	..	..	23	..	596
Hudson & Manhattan	62	29	1	8	7	..	6	6	..	11	1	..	153	21	1	99	52	..	..	..	..	4	..	..	461
Long Island	198	152	13	61	48	4	25	36	..	136	70	3	235	145	28	323	99	2	..	..	..	231	40	..	1,849
Maryland, Delaware & Virginia	2	8	1	2	3	..	1	1	..	..	..	..	1	..	..	3	2	..	..	..	..	..	..	..	24
New York, Philadelphia & Norfolk	36	25	8	9	11	..	4	5	..	10	10	..	20	13	..	44	14	..	..	..	..	47	8	..	264
Pennsylvania R. R. Lines, West	1,856	1,110	163	581	434	33	261	271	3	391	154	18	562	95	14	3,911	368	15	27	22	..	76	18	..	10,388
Pennsylvania R. R. Lines, East	10,547	4,356	771	2,253	914	39	1,412	1,446	30	1,813	454	21	2,829	468	47	14,820	3,225	35	296	164	6	1,773	349	9	48,077
Philadelphia & Reading	1,182	693	430	430	241	6	214	212	..	197	96	..	326	103	6	2,563	388	5	79	45	..	9	9	..	6,868
P., C., C. & St. Louis	2,594	1,102	194	680	339	29	360	357	9	364	147	15	352	39	3	4,199	350	12	12	5	1	671	128	..	11,962
Port Reading Railroad	5	2	..	4	3	..	2	2	..	..	..	..	4	..	..	38	2	..	..	..	..	..	..	..	62
Staten Island Rapid Transit	89	46	..	23	11	..	8	6	..	6	3	..	14	6	..	65	2	..	..	..	..	95	9	..	383
Western Maryland	337	203	100	94	80	16	41	58	8	57	43	4	27	9	1	749	27	4	1	..	..	675	10	..	2,544
West Jersey & Seashore	22	18	5	18	13	1	8	2	1	14	2	..	151	21	5	51	11	3	..	..	..	44	19	..	409
	20,995	10,576	1,183	5,639	3,508	227	2,891	3,002	66	3,704	1,353	95	5,336	1,160	228	36,009	5,980	119	495	338	10	6,774	1,009	16	111,413
Ratio	....	1.9	11.0	....	1.6	25.2	....	.9	43.8	....	2.7	38.9	....	4.6	23.4	....	6.0	303.0	....	1.4	49.5	....	6.7	423.3	.....

TABLE III—MECHANICS, HELPERS AND APPRENTICES IN ALL DEPARTMENTS, BY CRAFTS—POCAHONTAS REGION.

Chesapeake & Ohio	859	528	168	254	276	53	165	245	13	142	73	31	280	45	9	2,571	535	109	6	18	1	201	174	..	6,756
Norfolk & Western	1,355	726	241	265	177	38	179	198	11	242	102	43	291	107	23	4,110	380	16	56	136	13	..	..	..	8,709
Virginian	129	119	28	34	34	7	25	26	1	30	18	6	16	2	1	306	14	9	..	..	..	323	..	..	1,128
	2,343	1,373	437	553	487	98	369	469	25	414	193	80	587	154	33	6,987	929	134	62	154	14	524	174	..	16,593
Ratio	....	1.7	5.3	....	1.1	5.6	....	.8	14.7	....	2.1	5.2	....	3.8	17.7	....	7.5	52.0	....	.4	4.4	....	3.0	....	.....

TABLE IV—MECHANICS, HELPERS, AND APPRENTICES IN ALL DEPARTMENTS, BY CRAFTS. SOUTHERN REGION.

Alabama & Vicksburg	5	6	..	2	4	..	1	1	..	..	..	..	7	..	..	23	..	..	..	..	..	..	..	..	49
Alabama Great Southern	92	52	18	25	22	4	18	24	2	12	14	2	22	3	1	154	36	3	..	..	..	..	..	..	504
Atlanta & West Point	35	20	4	6	10	2	6	10	..	12	8	1	4	1	..	73	14	2	..	..	..	16	4	..	228
Atlanta, Birmingham & Atlantic	39	42	7	11	17	2	6	12	3	6	11	4	2	1	..	121	35	12	..	..	..	16	4	1	352
Atlantic Coast Line	543	412	109	188	255	40	108	183	23	99	91	25	93	47	10	1,670	251	73	18	15	5	207	56	1	4,522
Carolina, Clinchfield & Ohio	62	29	19	13	11	4	7	15	1	8	2	5	6	1	..	146	15	13	1	3	..	..	..	..	361
Central of Georgia	192	104	43	51	70	11	37	63	9	44	17	10	27	7	2	427	217	67	1	1	..	45	..	..	1,445
Charleston & Western Carolina	30	19	6	9	13	2	9	8	1	4	4	2	2	1	..	52	10	2	..	..	..	6	10	..	190
Cin., N. O. & Texas Pacific	245	186	55	59	54	9	48	56	3	41	35	9	68	13	6	600	34	27	4	3	1	..	..	..	1,556
Florida East Coast	63	60	10	18	25	5	14	17	1	15	9	1	20	1	1	226	37	2	2	2	..	27	..	1	557
Georgia Railroad	40	28	4	80	17	3	9	18	1	7	4	4	2	..	..	113	16	9	..	..	..	25	4	..	384
Georgia Southern & Florida	43	32	8	13	19	3	9	12	1	6	6	..	3	..	1	121	19	10	..	..	..	..	..	..	306
Gulf & Ship Island	20	11	14	5	9	2	6	7	..	3	1	1	..	..	..	97	14	1	..	..	..	5	1	..	197
Gulf, Mobile & Northern	34	24	8	6	9	3	7	11	1	4	2	2	..	..	..	69	13	3	..	..	..	20	6	..	222
Illinois Central	1,638	1,054	520	612	626	80	244	321	19	326	69	51	376	183	..	5,472	502	65	18	10	6	118	503	..	12,813
Louisville & Nashville	1,300	918	235	489	545	37	253	331	3	240	141	18	116	12	7	4,811	434	114	86	99	..	5,720	..	..	15,909
Louisville, Henderson & St. Louis	11	7	2	4	3	1	2	1	1	2	..	1	2	..	1	34	1	2	..	..	..	2	..	1	78
Mississippi Central	10	4	3	2	4	1	3	5	1	1	..	..	1	..	1	16	..	..	..	..	..	28	4	..	84
Mobile & Ohio	220	180	38	65	75	14	34	52	7	25	24	5	10	3	1	723	104	75	9	8	..	146	10	..	1,828
Nashville, Chattanooga & St. Louis	220	178	19	66	46	..	33	50	..	45	22	..	79	13	..	810	121	4	23	10	1	..	..	..	1,740
New Orleans & Northeastern	92	63	20	26	42	4	28	43	4	17	12	3	17	3	2	525	19	1	1	1	..	..	..	..	923
New Orleans Great Northern	26	23	6	4	10	1	4	5	..	4	2	..	1	1	..	68	13	50	..	..	..	1	..	..	219
Norfolk Southern	45	36	7	13	15	4	13	15	2	11	8	1	5	5	2	159	28	..	..	..	..	25	..	..	394
R. G. & Potomac	95	45	18	26	26	2	21	27	2	20	17	3	23	7	..	207	9	..	1	..	..	35	24	..	608
Seaboard Air Line	355	244	76	88	23	118	56	100	11	57	63	15	35	10	4	705	46	..	10	26	1	345	98	3	2,489
Southern	1,133	933	216	328	393	66	181	256	29	183	146	44	138	37	35	3,553	314	136	39	8	6	133	..	..	8,307
Southern in Mississippi	15	13	3	4	5	1	2	4	1	1	1	1	..	..	..	42	2	3	..	..	..	6	5	..	109
Tennessee Central	25	23	6	8	9	2	6	9	1	7	4	1	1	1	..	89	8	..	..	..	..	..	..	..	200
Washington Southern	..	..	..	..	..	..	..	..	..	..	..	..	12	..	..	....	..	..	..	..	..	..	..	..	12
	6,628	4,746	1,474	2,221	2,357	421	1,165	1,656	127	1,200	713	209	1,072	350	74	21,106	2,312	674	213	186	20	6,926	729	7	56,586
Ratio	....	1.4	4.5	....	.9	5.2	....	.7	9.1	....	1.4	5.7	....	3.0	14.5	....	9.1	31.3	....	1.1	10.0	....	9.5	989.4	.....

TABLE V—MECHANICS, HELPERS AND APPRENTICES IN ALL DEPARTMENTS, BY CRAFTS—NORTHWESTERN REGION

Railroad	Machinists			Boilermakers			Blacksmiths			Sheet Metal Workers			Electrical Workers			Carmen			Moulders			Other Mechanics			Grand Totals
	Machinists	Helpers	Apprentices	Boilermakers	Helpers	Apprentices	Blacksmiths	Helpers	Apprentices	Sheet Metal Workers	Helpers	Apprentices	Electrical Workers	Helpers	Apprentices	Carmen	Helpers	Apprentices	Moulders	Helpers	Apprentices	Other Mechanics	Helpers	Apprentices	
Chicago & North Western	1,446	947	212	525	529	64	227	285	15	350	132	22	367	117	149	4,686	482	13	23	35	..	802	18	..	11.446
Chicago Great Western	308	153	42	109	59	6	42	51	5	39	16	..	105	35	3	682	52	4	18	9	..	66	7	..	1,811
Chicago, Milwaukee & St. Paul	2,074	1,758	283	727	636	46	552	852	23	328	186	5	359	64	45	4,996	247	2	98	5	..	981	254	1	14,552
Chicago, St. Paul, Minn. & Omaha	308	125	47	139	123	10	65	74	4	52	10	10	37	1	12	912	41	10	3	2	..	40	..	1	2,026
Duluth & Iron Range	62	55	12	23	29	5	15	19	1	10	5	1	9	4	1	145	14	..	3	1	..	22	..	..	436
Duluth, Missabe & Northern	78	94	16	18	38	4	15	16	..	15	17	4	34	9	4	140	27	..	..	..	..	16	..	..	545
Duluth, South Shore & Atlantic	40	29	16	18	19	3	10	12	1	4	..	2	2	..	..	150	18	1	1	..	1	..	..	..	327
Elgin, Joliet & Eastern	159	126	22	73	79	7	44	57	20	29	19	1	42	3	1	1,333	162	15	..	..	..	..	..	..	2,172
Great Northern	1,025	682	218	367	356	22	194	216	4	188	103	16	85	20	2	4,172	173	4	10	..	..	1,255	331	6	9,449
Minneapolis & St. Louis	161	91	26	75	63	6	30	33	..	28	12	..	8	2	..	565	27	21	2	1	..	27	1	..	1,179
Minneapolis, St. Paul & S. Ste. Marie	396	250	63	131	127	8	74	66	3	72	19	2	88	15	1	1,726	80	8	9	6	..	44	..	..	3,208
Mineral Range	9	9	6	3	7	3	5	5	2	1	1	..	..	..	..	33	..	..	..	..	..	..	..	..	84
Minnesota & International	15	11	3	2	1	1	1	1	..	1	..	..	2	5	..	7	..	..	..	..	..	3	8	..	61
Northern Pacific	789	463	168	267	362	44	150	217	6	37	12	10	158	..	8	3,223	16	1	..	..	..	589	76	..	6,596
Oregon-Washington R. R. & Nav.	245	177	26	88	112	4	42	36	1	30	11	..	82	4	..	532	52	..	14	5	..	237	..	..	1,698
Southern Pacific (N. of A.)	151	87	21	31	35	4	38	14	..	7	1	..	79	4	..	256	35	..	..	..	..	..	..	..	763
Spokane, Portland & S.	49	24	7	17	16	2	10	6	1	9	5	..	20	2	..	85	36	..	..	..	..	168	..	..	457
	7,315	5,081	1,188	2,613	2,591	239	1,514	1,980	66	1,200	549	73	1,477	285	226	23,643	1,462	79	181	64	1	4,250	695	8	56,810
Ratio	....	1.4	6.1	....	1.08	10.9	....	.7	22.9	....	2.3	16.4	....	5.2	6.5	....	16.2	299.2	....	2.8	181.0	....	6.1	531.2	.....

TABLE VI—MECHANICS, HELPERS AND APPRENTICES IN ALL DEPARTMENTS, BY CRAFTS—CENTRAL-WESTERN REGION.

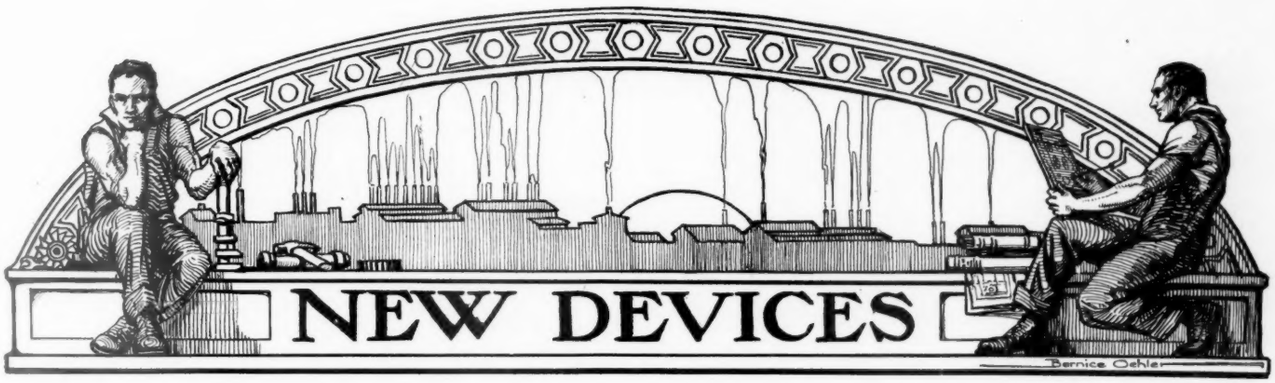
Arizona Eastern	32	17	10	16	19	2	4	8	..	9	7	1	4	..	..	39	3	..	..	..	..	9	6	..	186
Atchison, Topeka & Santa Fe	2,755	1,470	834	872	623	225	345	288	10	479	193	47	448	74	9	5,116	527	38	..	..	..	433	3	..	14,789
Chicago & Alton	369	279	79	139	123	20	52	89	8	61	50	10	76	35	2	884	136	13	22	17	3	19	11	..	2,497
Chicago & Eastern Illinois	327	322	35	120	195	20	64	106	5	70	45	9	54	12	5	1,483	199	13	1	1	..	124	..	..	3,210
Chicago, Burlington & Quincy	1,774	1,111	334	688	585	54	260	326	5	459	141	24	172	20	6	4,994	689	31	34	9	1	336	62	..	12,115
Chicago Peoria & St. Louis	41	33	5	22	24	3	7	11	..	4	2	..	1	..	..	62	4	..	..	..	..	1	..	..	220
Chicago, Rock Island & Pacific	1,405	1,036	205	542	530	78	176	267	28	396	218	28	228	59	25	4,022	473	48	..	..	..	..	..	..	9,764
Chicago, Terre Haute & S. E.	72	36	15	23	25	6	6	7	..	1	..	1	2	..	..	257	19	5	..	..	..	14	4	..	493
Colorado & Southern	156	126	24	52	46	11	19	27	22	22	10	4	10	..	..	182	21	4	..	..	..	41	20	..	797
Denver & Rio Grande	502	231	93	146	131	27	66	103	9	98	58	12	24	8	2	1,198	56	6	2	2	1	..	..	..	2,775
Denver & Salt Lake	62	56	15	19	24	1	13	24	1	13	7	1	1	..	..	110	11	2	..	..	..	42	31	..	433
El Paso & Southwestern	124	80	68	48	55	4	19	25	2	24	12	5	5	..	..	289	23	3	..	..	..	..	..	..	713
Fort Worth & Denver City	92	68	19	37	46	8	13	18	2	2	..	..	..	2	1	248	..	2	..	..	..	55	18	4	635
Los Angeles & Salt Lake	197	167	36	98	106	5	27	41	..	46	23	4	41	6	..	276	38	4	..	..	..	..	..	..	1,115
Northwestern Pacific	38	29	16	9	12	..	7	8	..	10	5	2	26	2	1	88	13	3	1	..	1	..	..	..	271
Oregon Short Line	337	202	55	117	106	6	38	25	2	86	8	3	89	10	14	877	53	3	17	6	4	16	..	..	2,074
St. Joseph & Grand Island	51	34	12	24	21	4	12	9	..	6	3	..	2	..	..	172	3	..	..	..	..	1	1	..	355
Southern Pacific (S. of A.)	664	470	227	222	325	24	126	162	12	160	55	30	113	15	13	1,533	375	70	2	4	..	209	181	..	4,992
Toledo, Peoria & Western	18	3	..	5	3	1	2	2	..	2	..	..	1	..	..	16	..	..	..	..	..	1	..	..	54
Union Pacific	932	811	177	315	360	19	124	167	2	333	174	12	356	68	22	2,481	299	31	2	..	..	28	..	..	6,713
Western Pacific	92	98	37	44	48	9	16	23	3	9	11	3	5	..	..	289	23	3	..	..	..	..	..	..	713
	10,040	6,679	2,296	3,558	3,407	527	1,396	1,736	111	2,890	1,230	196	1,676	313	100	24,622	3,003	292	81	39	10	1,342	346	4	65,086
Ratio	....	1.5	4.3	....	1.04	6.7	....	.7	12.6	....	1.04	11.6	....	5.3	16.7	....	7.5	84.3	....	2.07	8.1	....	3.8	335.5	.....

TABLE VII—MECHANICS, HELPERS AND APPRENTICES IN ALL DEPARTMENTS, BY CRAFTS—SOUTHWESTERN REGION

Railroad	Machinists			Boilermakers			Blacksmiths			Sheet Metal Workers			Electrical Workers			Carmen			Moulders			Other Mechanics			Grand Totals
	Machinists	Helpers	Apprentices	Boilermakers	Helpers	Apprentices	Blacksmiths	Helpers	Apprentices	Sheet Metal Workers	Helpers	Apprentices	Electrical Workers	Helpers	Apprentices	Carmen	Helpers	Apprentices	Moulders	Helpers	Apprentices	Other Mechanics	Helpers	Apprentices	
Fort Worth & Rio Grande	11	12	..	4	5	..	2	2	..	2	2	..	..	..	..	29	..	..	..	..	..	6	..	..	75
Gulf Coast Lines	71	77	16	20	28	4	18	31	2	18	15	4	1	..	1	251	73	9	..	..	..	226	57	..	922
Gulf, Colorado & Santa Fe	202	99	97	93	66	19	20	31	3	20	3	8	43	9	7	453	60	57	..	..	..	..	..	..	1,290
International & Great Northern	187	148	32	101	146	20	42	76	3	46	42	8	7	1	1	499	27	25	..	..	..	50	7	1	1,469
Kansas City, Mexico & Orient	54	41	9	37	37	5	5	8	1	8	3	1	1	..	..	120	..	3	..	..	..	11	..	..	344
Kansas City Southern	174	110	33	33	56	11	25	31	4	31	20	7	13	2	2	492	12	18	1	..	..	119	38	..	1,232
Louisiana & Arkansas	13	10	2	4	4	1	5	7	1	2	2	1	2	..	..	52	6	2	..	..	..	74	..	..	188
Midland Valley	27	24	4	14	16	1	6	9	1	4	4	1	1	..	1	86	..	2	..	..	..	22	12	..	235
Missouri & North Arkansas	17	16	2	9	10	..	3	4	..	3	3	1	3	..	..	52	6	..	..	..	..	33	50	..	212
Missouri, Kansas & Texas	316	296	61	133	180	19	72	91	8	63	52	14	79	18	3	1,012	137	27	18	..	1	58	39	2	2,699
Missouri, Kansas & Texas of Texas	257	261	41	109	144	18	53	51	2	39	28	3	87	12	2	667	62	21	..	..	..	42	10	..	1,879
Missouri, Oklahoma & Gulf	24	25	5	14	18	2	6	9	..	2	3	1	1	1	..	89	4	..	..	..	..	2	2	..	208
Missouri Pacific	1,099	986	194	476	484	65	218	310	21	208	163	20	163	15	3	3,175	239	80	2	1	..	477	29	13	8,441
St. Louis-San Francisco	905	555	133	296	285	46	110	129	16	208	118	25	181	53	13	1,440	125	29	1	..	..	91	10	6	4,775
St. Louis, San Francisco & Texas	34	42	7	12	19	3	7	10	..	6	9	2	2	..	..	57	..	..	..	..	..	14	..	..	224
St. Louis Southwestern	79	92	14	27	38	5	27	39	4	21	17	4	5	12	..	493	31	24	..	..	..	5	2	..	939
St. Louis Southwestern of Texas	66	65	11	30	55	5	19	41	2	12	12	2	5	..	..	236	59	..	..	..	..	4	2	..	626
San Antonio & Aransas Pass	59	53	15	21	34	8	11	18	..	12	8	3	7	..	..	195	27	2	..	..	..	7	..	..	480
San Antonio, Uvalde & Gulf	13	13	7	6	7	2	2	2	1	2	2	1	3	..	..	21	3	1	..	..	..	15	4	..	105
Texas & Pacific	328	302	70	156	186	18	62	87	10	60	62	10	19	8	1	607	56	56	5	7	..	396	45	..	2,551
Trinity & Brazos Valley	9	12	3	6	8	2	2	3	..	1	3	2	3	..	..	50	2	9	..	..	..	45	15	..	175
Vicksburg, Shreveport & Pacific	31	27	7	11	11	2	11	13	2	6	4	1	1	..	..	78	20	6	..	..	..	5	35	..	271
Wichita Falls & Northwestern	1	2	..	2	3	..	..	..	..	..	..	..	1	..	..	11	..	..	..	..	..	7	7	..	34
	3,977	3,268	763	1,614	1,840	256	726	1,002	81	774	575	119	598	131	34	10,165	949	371	27	8	1	1,709	364	22	29,374
Ratio	....	1.2	5.2	....	.8	6.3	....	.7	8.9	....	1.3	6.5	....	4.5	17.6	....	10.7	27.4	....	3.3	27.0	....	4.7	77.6	.....

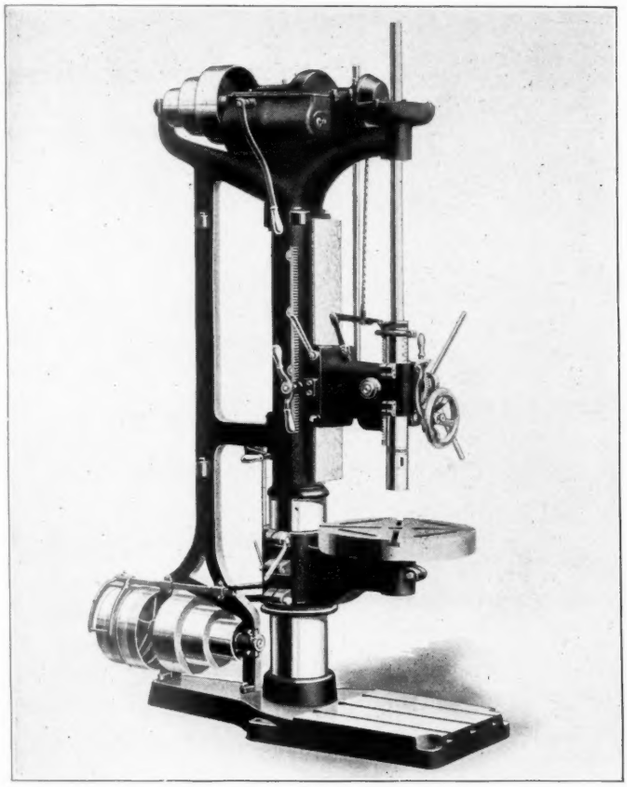
TABLE VIII—MECHANICS, HELPERS AND APPRENTICES IN ALL DEPARTMENTS, BY CRAFTS—ALL REGIONS

Eastern	....	1.5	6.7	....	1.2	12.4	....	.9	24.0	....	2.4	23.5	....	3.0	21.8	....	8.2	130.8	....	2.0	15.9	....	2.4	56.9	.....
	16,302	10,635	2,421	5,250	4,238	421	2,564	2,635	107	2,873	1,204	122	4,609	1,505	211	41,106	4,965	314	254	123	16	6,948	2,865	122	111,864
Allegheny	....	1.9	11.0	....	1.6	25.2	....	.9	43.8	....	2.7	38.9	....	4.6	23.4	....	6.0	303.0	....	1.4	49.5	....	6.7	423.3	.....
	20,995	10,576	1,883	5,639	3,508	227	2,891	3,002	66	3,704	1,353	95	5,336	1,160	228	36,009	5,980	119	495	338	10	6,774	1,009	16	111,463
Pocahontas	....	1.7	5.3	....	1.1	5.6	....	.8	14.7	....	2.1	5.2	....	3.8	17.7	....	7.5	52.1	....	.4	4.4	....	3.0	0	.....
	2,342	1,343	437	553	467	98	369	469	25	414	193	80	587	154	33	6,987	929	134	62	154	14	524	174	0	16,583
Southern	....	1.4	4.5	....	.9	5.2	....	.7	9.1	....	1.4	5.7	....	3.0	14.5	....	9.1	31.3	....	1.1	10.0	....	9.5	989.4	.....
	6,628	4,746	1,474	2,221	2,357	421	1,165	1,656	127	1,200	713	209	1,072	350	74	21,106	2,312	674	213	186	20	6,926	729	7	56,586
Central Western	....	1.5	4.3	....	1.04	6.7	....	.7	12.6	....	1.04	11.6	....	5.3	16.7	....	7.5	84.3	....	2.07	8.1	....	3.8	335.5	.....
	10,040	6,679	2,296	3,558	3,407	527	1,396	1,736	111	2,290	1,230	196	1,676	313	100	24,622	3,003	292	81	39	10	1,342	346	4	65,086
Northwestern	....	1.4	6.1	....	1.08	10.9	....	.7	22.9	....	2.3	16.4	....	5.2	6.5	....	16.2	299.2	....	2.8	181.0	....	6.1	531.2	.....
	7,315	5,081	1,188	2,613	2,591	239	1,514	1,980	66	1,200	549	73	1,477	285	226	23,643	1,462	79	181	64	1	4,250	695	8	56,810
Southwestern	....	1.2	5.2	....	.8	6.3	....	.7	8.9	....	1.3	6.5	....	4.5	17.6	....	10.7	27.4	....	3.3	27.0	....	4.7	77.6	.....
	3,977	3,268	765	1,614	1,840	256	726	1,002	81	774	575	119	598	131	34	10,165	949	371	27	8	1	1,709	364	22	29,374
Ratio	....	1.6	6.5	....	1.2	9.8	....	.9	12.9	....	2.1	13.9	....	3.9	16.9	....	8.3	82.5	....	1.4	18.3	....	4.6	159.6	.....
Totals	67,600	42,328	10,462	21,448	18,428	2,189	10,625	12,480	533	12,455	5,617	894	15,355	3,898	906	163,638	19,600	1,983	1,313	912	72	28,473	6,182	179	447,770
Pullman Lines	....	2.2	53.5	....	....	....	....	1.0	....	....	4.9	55.4	....	10.4	18.9	....	6.9	5.2	....	....	....	....	....	....	.....
	107	49	2	....	....	....	46	48	....	388	79	7	698	67	37	2,171	315	42	....	....	....	....	....	....	4,056
Average ratio	....	1.6	6.5	....	1.2	9.8	....	.9	20.0	....	2.2	14.3	....	4.0	17.0	....	8.3	81.9	....	1.4	18.3	....	4.6	159.6	.....
Grand Totals	67,707	42,377	10,464	21,448	18,428	2,189	10,671	12,528	533	12,843	5,896	901	16,053	3,965	943	165,809	19,915	2,026	1,313	912	72	28,473	6,182	179	451,826



SLIDING HEAD DRILLING MACHINE

An upright sliding head drilling machine built by the Sibley Machine Company, South Bend, Ind., includes several new features not found in preceding types. The machine as now being built has a swing of 24 in. and the 25-in. vertical adjustment of the head makes it possible to drill work held

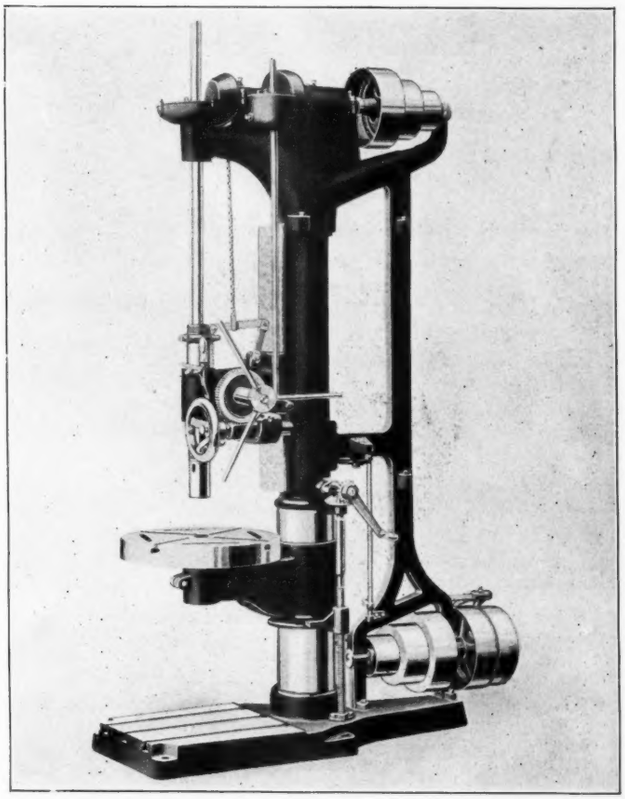


Sliding-Head Drilling Machine With the Cast Bearings

in large jigs. Positive geared feeds are provided and both speeds and feeds are selective and have a wide range. To insure strength and rigidity for heavy duty the base of the drill is well ribbed and braced. Increased length of bearings on the head and the arm and substantial table support give added strength and accuracy. A weight to counterbalance the head and the spindle is supported inside the column by a Diamond chain operating over large diameter sheaves. All gears are enclosed to insure the safety of the operator and belt guards can be furnished if desired.

The fitting of all drive shaft bearings with die-cast split bushings made of anti-friction metal is stated to be an exclusive feature of this machine. These bearings are easily interchangeable and their use insures a long life for the bearings. Attention is called to the new geared feed with four changes and a neutral position. The feed changes are obtained by moving a knob conveniently located in the center of the handwheel, in connection with a sliding spline, four feeds being provided for each spindle speed. The initial drive of the feed shaft is from the top cone shaft through spur and spiral gears. This arrangement is very compact so the gears can be completely enclosed and run in an oil bath. The steel worm which meshes with the large worm gear also runs in an oil pocket.

The adjustable automatic stop of new design is quick and positive in action. Hand feed and quick return of the spindle



Four Feed Changes are Obtained Through the Feed Gears and Spline

is effected through the medium of a three-legged spider, at the right of the feed box. Special attention has been given to the oiling of the machine. All bearings are equipped with oil cups, grooves and channels, which insure a proper dis-

tribution of oil to the vital points. All feed gears in the feed case are completely enclosed and run in oil. A positive geared tapping attachment, geared or belted motor drive, round or square table with T-slots and oil pocket, oil pump outfit complete and quarterturn countershaft can be furnished as special equipment with this machine. The total height of the drill is 94 in. and the maximum distance from the spindle to the table and base are 35½ in. and 52½ in., respectively, while the head and the table have a traverse on the column of 25 in. and 13 in., respectively.

GEARED HEAD LATHE

The patented geared head lathe illustrated is manufactured by the Cincinnati Lathe & Tool Company, Cincinnati, Ohio, and is arranged for single-pulley belt drive, directly from a line shaft. The lathe may be arranged for direct motor drive by mounting the motor on the headstock or in the rear of the cabinet leg. In this case the drive is through belting, silent chains or gearing. Variations in speed are obtained in the head, therefore only constant speed motors are required. Twelve mechanical speed changes in geometrical progression are secured on these lathes by means of sliding gears. The movement of the gears is controlled by three shifting levers, and their operation and use is plainly indicated. The levers and gearing are so arranged that they will not lock while operating, and any lever may be shifted without interfering with the others.

The index plates are simple and easily read, so that the most inexperienced operator will have no trouble in obtaining any speed or feed desired. The spindle may be stopped by the usual control lever on the right of the apron.

The design of this lathe is somewhat similar to the line of lathes manufactured by the Cincinnati Lathe & Tool Company, except that the method of driving the spindle through the gears makes the lathe rather more adaptable to manufacturing work than to tool work. Abundant power is provided to drive the lathes under heavy cuts, and the easy and quick manipulation of operating levers has also been provided for. The latter can be provided with a hexagon turret if desired.

LIMIT SCREW PITCH GAGE

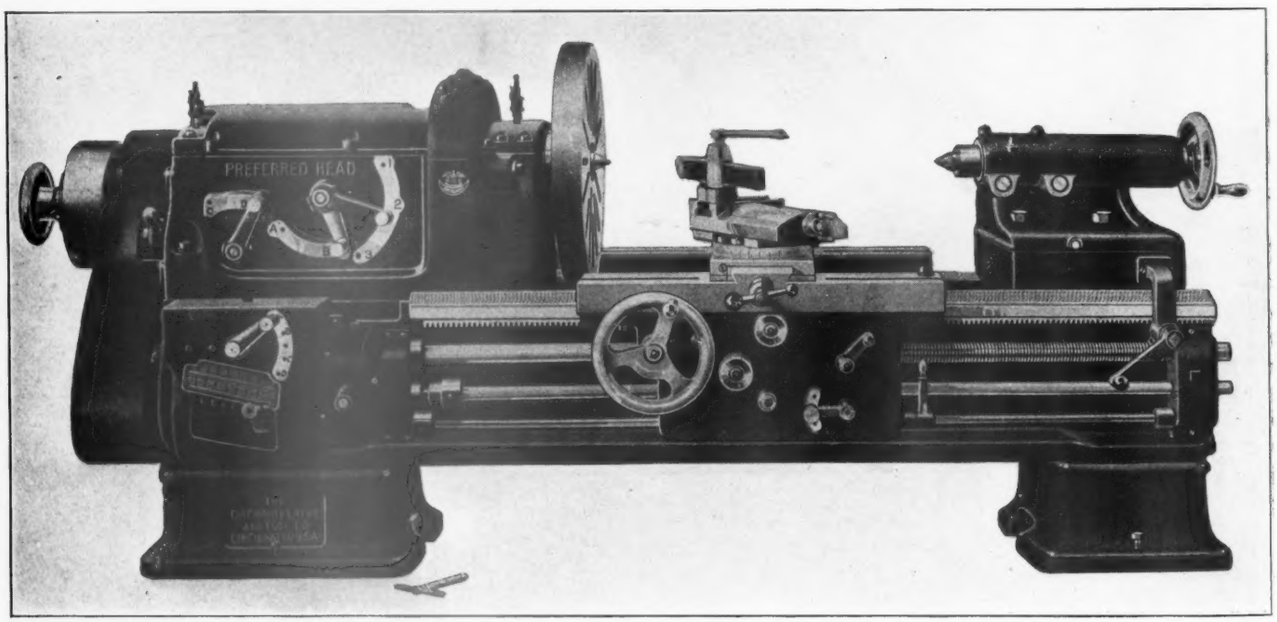
In the past many screw pitch gages have been made with no tolerance and a normal lead only. A new development in these gages which adds to their usefulness is shown in the illustration. As indicated, two additional surfaces are provided on the reverse side, one of which is cut with a lead .002 in. long and the other .002 in. short, thus making a limit gage. When the old style of gage was laid in the thread of a screw it was possible to check the lead on the screw, but in case the lead was not correct, it was impossible to tell how much of an error existed.

Many tool room foremen favor a type of plug gage which unfortunately has the same disadvantages mentioned above and in addition is susceptible to inaccuracies due to wear and is a time consumer in use.

With the new style gage illustrated, if the thread to be tested is not normal it can be determined readily whether the thread is longer or shorter than the limit portion of the gage, or whether the error is between these limits. The gages are made for the present to control lead limits of plus and minus .002 in., which is the most generally used lead limit. Eventually it is intended to supply gages with tolerances of .001, .003 and .004 in. for both long and short lead.

Greenfield Limit Screw Pitch Gage

When using the gages it is essential that the work being tested, as well as the gage, is clean in the thread and that the gage is held in the screw in a position parallel to the axis. In testing the thread with this gage the work should be held up to the eye in front of a bright light, so that the resulting error in lead can be detected easily. The gage is manufactured by the Greenfield Tap & Die Corporation, Greenfield, Mass.

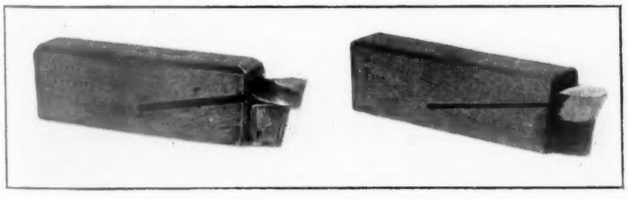


Geared Head Lathe Manufactured by the Cincinnati Lathe & Tool Company

MARTIN TOOL HOLDER

The tool holder illustrated, has been designed for use with broken and worn high speed steel drills and tool bits, and is manufactured by the Martin Tool Holder Company, Jackson, Tenn. The body of the holder is made of tool steel, and will last practically indefinitely. The cutting edge of the tool, being made of broken high speed steel drills, reamers, etc., will stand up under heavy cuts, and there is a saving of expensive high speed steel scrap, which would otherwise be of no value save for the expensive operations of remelting and reforging.

The method of holding and grinding the tool bit is clearly shown in the illustration, and either round or square bits can be utilized. It is claimed that this form of tool holder is capable of taking cuts limited only by the power of the machine.

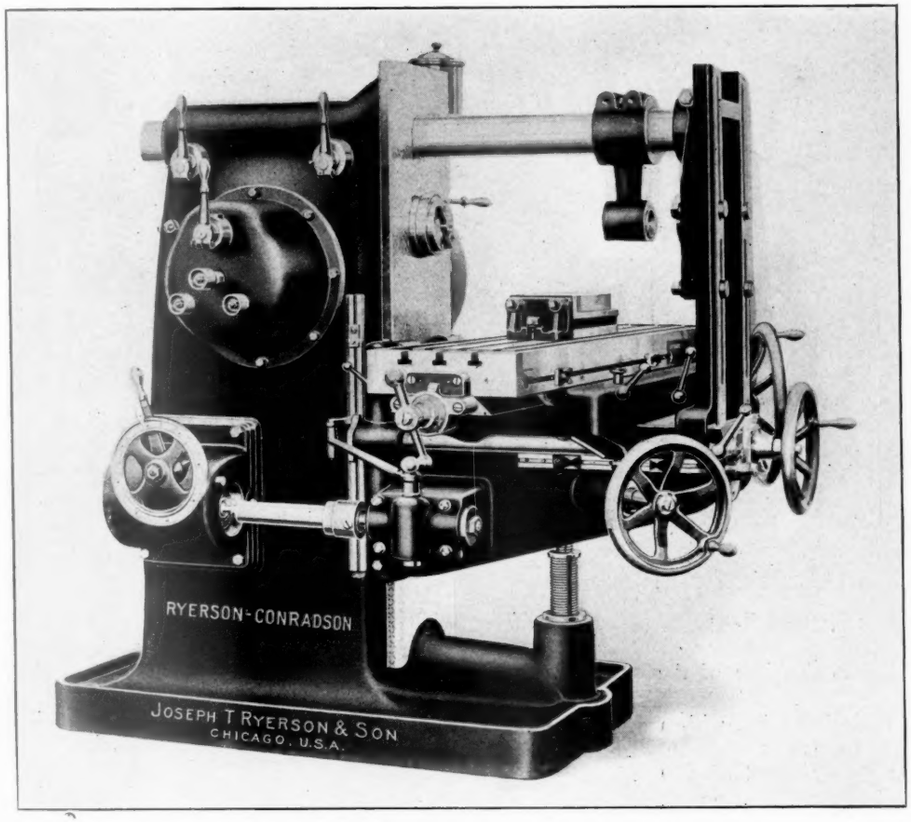


Tool Holder Designed for Use With Broken High Speed Steel Drills and Tool Bits

Martin tool holders are made in all standard sizes, and the absence of large bosses or set screws, saves much of the operator's time previously spent in handling, grinding and changing heavy solid tools. The resulting economy is obvious.

HIGH POWER MILLING MACHINE

The milling machine, designed for high production, is now recognized as a more or less universal tool, and there has been a steady increase in the range of work that can be performed on it. Great power, rigidity, convenience of operation and adaptability to light or heavy manufacturing or jobbing work is provided for in the new No. 3 plain milling machine recently placed on the market by Joseph T. Ryerson & Son, Chicago. The most striking feature in the design of this machine lies in the application of the helical drive. When this form of drive is used the constant turning power applied to the milling cutter not only insures a better grade of work, but increases the life of the cutter. The objection to helical drive gearing in the past has been the inability to secure a sufficiently wide range of speeds for a commercial machine, but this difficulty has been overcome in the machine illustrated.



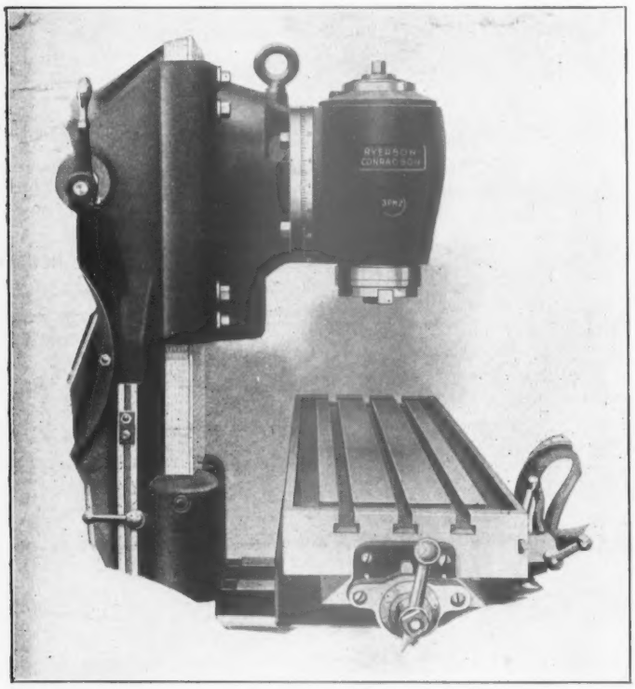
Front View of Ryerson-Conradson No. 3 Plain Miller

The column is a rigid casting, thoroughly ribbed internally and cast integral with the base. The face of the column is extended above the over-arm, thus affording a very thorough support for special fixtures. The heavy type vertical milling attachment with this solid backing is capable of taking as heavy a cut as the main spindle. The knee is heavy and deep, absorbing vibration due to heavy cuts. The bearing surface between the knee and the column is greatly increased by extending the back of the knee up to a point nearly level with the top of the table. The elevating screw telescopes the knee, and is located at its center of gravity to avoid all binding action when raising or lowering. The hand-wheel controling longitudinal table travel extends diagonally from the side of the saddle. The spindle is of .60 carbon steel, accurately ground and runs in phosphor bronze bearings, which are adjustable for wear. The base plate is forged integral with the spindle and is arranged with two large keys for driving face mills and arbors. Twelve spindle speeds are available, ranging from 17 to 290 r.p.m. in practically geometrical progression. The driving pulley is of the conical friction clutch type and means are provided to automatically apply a brake to the shaft as soon as the clutch is disengaged.

The feed drive is positive from the primary shaft by means of a chain and sprocket. Eight changes are provided, ranging from .6 in. to 22.3 in. per minute. Each feed screw is provided with a graduated dial reading to thousandths of an inch and readily set back to zero. All feeds are equipped with six trips and the table can be stopped at any desired position along its travel.

The vertical milling attachment illustrated is made in three sizes, and clamped to the column dove-tail, no dependence being placed on the over-arm. The heavy pattern type has the same diameter spindle and the same bronze bearing as the main spindle. The taper hole face plate and driving keys also are the same, permitting as heavy a

cut to be taken as on the horizontal spindle. This is a particularly important feature. The drive is effected by a large aluminum bronze gear, bolted to the face plate of the main spindle and driven by the cross key. In return it engages a steel gear on a horizontal shaft, driving the vertical spindle through a set of bevel gears. This allows the



Vertical Milling Attachment of Semi-Universal Type

spindle to be set at any angle parallel to the face of the column. A draw bolt is furnished.

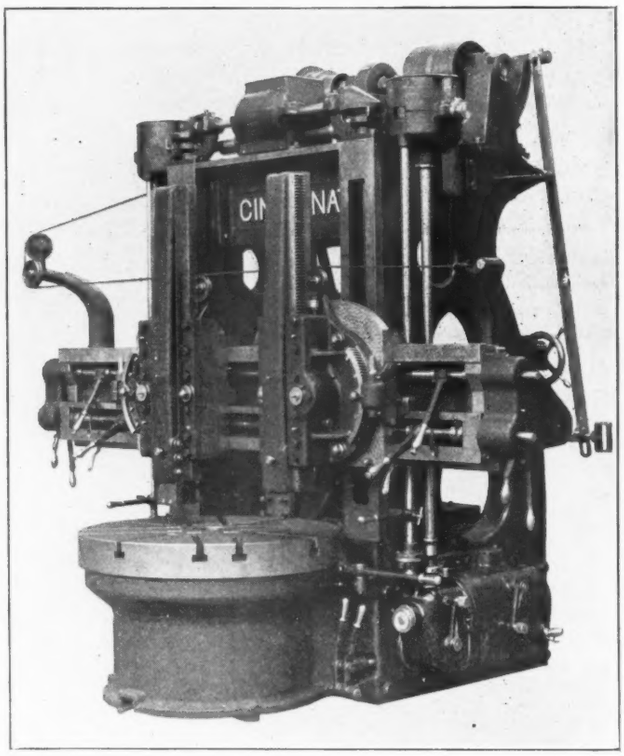
The longitudinal movement of the table is 35 in., with a cross movement of 14⅝ in. and vertical movement of 20 in. The machine is driven at a constant pulley speed of 600 r.p.m., requiring a motor of from 5 to 7½ rated horsepower.

MEDIUM SIZED BORING MILLS

With an appreciation of the need of a boring mill to take heavy cuts on medium and small sized work, the Cincinnati Planer Company, Cincinnati, Ohio, has recently added to its line of boring mills a new machine built in 42 in. and 48 in. sizes, one of which is shown in the illustration. These are high production machines, built to take heavy cuts at high speed. They have a capacity of two inches over the rated size, and take 39 in. under the tool holder.

The table is driven by a large, accurately planed bevel gear. The large bevel pinion which meshes into it has a double bearing in the bed, thus insuring smooth motion of the table. Among other advantages may be mentioned the fact that the spindle and track, and also all bearings in the speed box, are oiled by forced lubrication. The bed is reinforced by heavy I-beam ribs and is bored out and bushed for all revolving parts. No pit is necessary for the driving mechanism. All gears in the feed and speed boxes are made of steel, and the enclosed feed boxes are provided with direct reading feeds. Rapid power traverse of the head is provided in each direction, and the traverse handle is adjustable to suit the operator. As a safety feature, the crank handle cannot be engaged when the rapid power traverse is used. Sensitive adjustments are provided for both heads. The housings are of box type construction and extend to the bottom of the bed. They are held in alinement with the bed by a tongue and grove. All gearing is completely covered and the steel feed racks have teeth cut the entire length.

The travel of the tool bar is 27 in. Eight feeds are provided, ranging from 1/40 in. to ½ in., and the range of table speeds is from 2.45 to 59.2 for the 42-in. size, and 2.1 to 50.5 for the 48-in. size. A 10-hp. motor is required to drive either of these boring mills, and if direct current is available, a 2 to 1 variable speed motor, not exceeding 500 to 1,000 r. p. m. is recommended. For variable speed motor drive, the cone pulleys are omitted and a single belt drive used instead. The motor is mounted on top of the arch and coupled directly to the driving shaft, as shown in



Cincinnati Boring Mill Built in 42-in. and 48-in. Sizes

the illustration. Boring mills of this type can be equipped with countershaft drive and a belt shifter, if desired. They can also be furnished with a constant speed motor on the arch, in place of the tight and loose pulleys.

Ease of manipulation and the proper placing of all control handles has been constantly kept in mind in the design of these 42-in. and 48-in. boring mills, and all unnecessary steps around the machine have been eliminated.

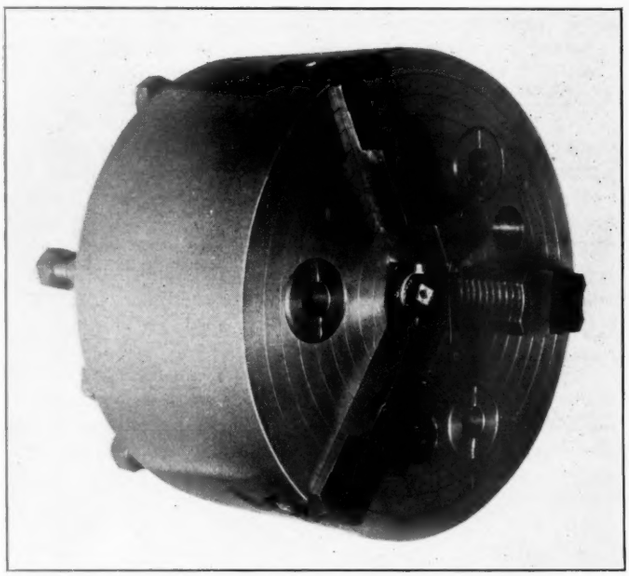
LAVOIE AIR CHUCK

About four years ago an air chuck was developed in a large manufacturing plant which was producing war material, and was the means of turning out a large production of small lathe work. This air chuck proved so satisfactory in operation that steps were taken to commercialize it, and it is now being manufactured by the Frontier Chuck & Tool Company, Buffalo, N. Y. While this chuck has been manufactured for only about six months, it is by no means a new and untried tool. It is a new departure in air chucks, owing to the fact that the component parts are all embodied in one unit.

The chuck cylinder and piston is an assembled unit,

mounted on a chuck base plate, which is attached to the spindle in the same manner as with an ordinary chuck. This feature greatly simplifies the application. The single unit is of such size as to insure rigidity and strength and because there is but one packing, the usual complications found in this class of equipment are eliminated. It is stated that the lever and wedge which control the action of the jaw embodies a positive clamping action, which is original with the Lavoie chuck. Due to its simplicity, the chuck may be expected to give satisfactory service over a long period of time. The packing used in the Lavoie chuck is of the cup leather type, and is applied to the piston by means of a ring and screws of such size as to insure saving of time on renewals.

The chuck is made in five sizes, varying from 8½ in. to 18 in., the length of the chuck from the spindle end to the face ranging from 6⅛ in. to 5¼ in. Six types of jaws are provided, varying from universal solid manufacturing jaws to combination three-step jaws for general chucking



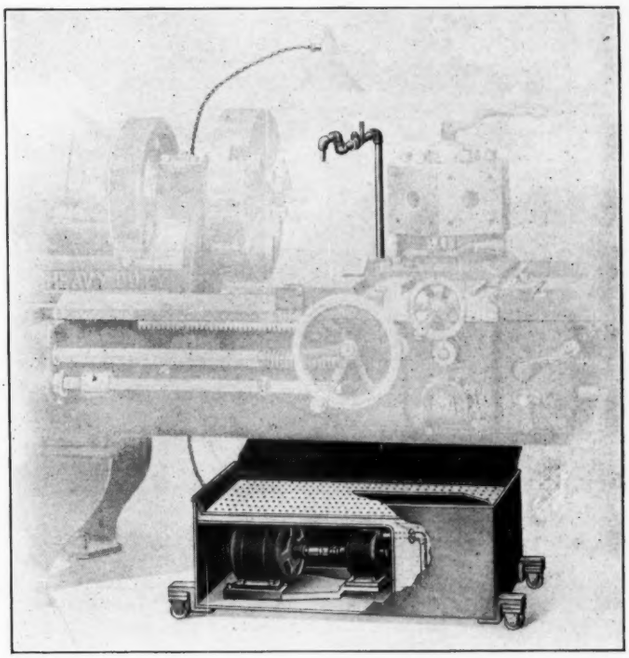
Air Chuck Manufactured by the Frontier Chuck and Tool Company

work and combination solid or detachable manufacturing jaws. An air box is used in connection with the Lavoie air chuck, and is necessary in order that the air pipe line can revolve with the spindle. The operating valve is a three-way cock, lever operated. One opening connects with the air supply, the second with the cylinder, and the third with the jaws. By the use of this valve only one pipe line is required.

PORTABLE LUBRICATING UNIT

The general design of a compact lubricating unit, manufactured by the Fulflo Pump Company, Blanchester, Ohio, is shown in the illustration. This portable unit was designed to fill the demand for a compact, inexpensive cutting tool lubrication system that could be quickly applied to any machine tool in the shop. Many machine shop tools are not equipped with a pan and pump, because they are used mostly for working on grey iron, but occasionally the machine may be used on malleable iron or steel, in which case a coolant is essential for the best results. In such cases, the portable unit illustrated can be used to good advantage. It may also be used on machines already provided with a coolant system, which for some reason or other is out of order. In this emergency the portable system shown can be immediately brought into place and production will not be interrupted.

The Fulflo pump illustrated is a complete, self-contained system, requiring nothing but attaching the motor cord to the lamp socket. The total height from the floor is only 14 in., which permits its being rolled under any ordinary lathe, as shown in the illustration. Provision is made for attaching additional splash boards when required. The pump and motor are completely covered, thus affording



Fulflo Portable Lubricating Unit Used with Turret Lathe

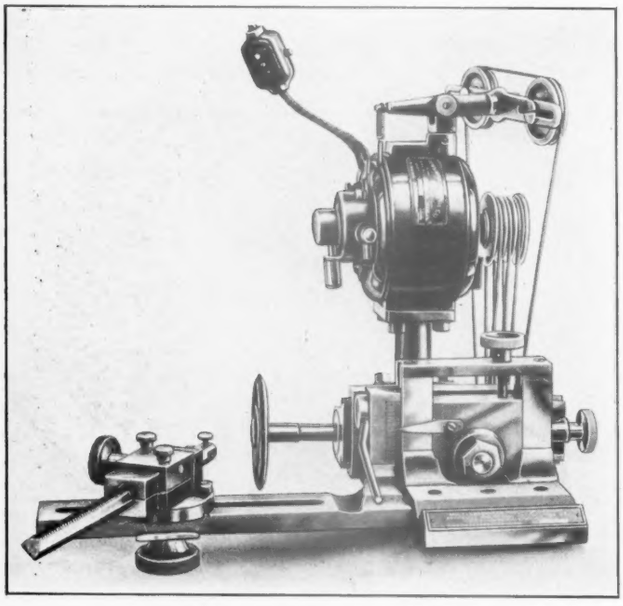
ample protection from both liquids and dust. The outfit can be used on grinding machines as well as on lathes, milling machines, drill presses, gear cutters, etc. There is only one moving part in the pump; namely, the impeller, which has no metal contact, and therefore cannot wear out quickly. It is packed with metallic packing which will not cut the shaft. The bearings are well lubricated, and since the shaft is hardened and ground, long, continued service may be expected.

MULTI GRADUATED PRECISION GRINDER

It has been difficult in the past to machine screw thread surfaces with the same accuracy obtained in machining cylindrical, flat or spherical surfaces. On account of this fact, it has been hard to make master thread gages and the machine illustrated was designed for this purpose by the Precision & Thread Grinder Manufacturing Company, Philadelphia, Pa. It can be used in conjunction with any machine tool and is adaptable to a variety of work, particularly thread grinding on lathes. The model *C* grinder illustrated is a right-hand attachment for use in front of the lathe center. Attention is called to the new style of wheel trueing arm, which is now attached to the base of the grinder in such a way that the thread angle is dressed on the wheel on a plane with the axis of the work centers, thus insuring a perfectly formed thread. This model also has a positioning pin for quickly locating the angle for V. U. S. and Whitworth threads.

The grinding spindles are carried in five precision ball bearings adjustable for radial wear and end thrust play. They are protected from abrasive dust by felt-lined steel

bushings. The spindle housing, carrying these ball bearings is provided with an oil reservoir, insuring continuous lubrication. The style of spindle bearings precludes the possibility of getting out of alinement, as in the case of solid bearings. Vibration and chatter are eliminated by making



Model C Precision Thread Grinder

the base and spindle housing proportionately massive and of solid construction. The spindle housing fulcrums in a vertical traverse plate and is indexed with graduations for setting to any angular inclination to conform to the helical angle of the thread.

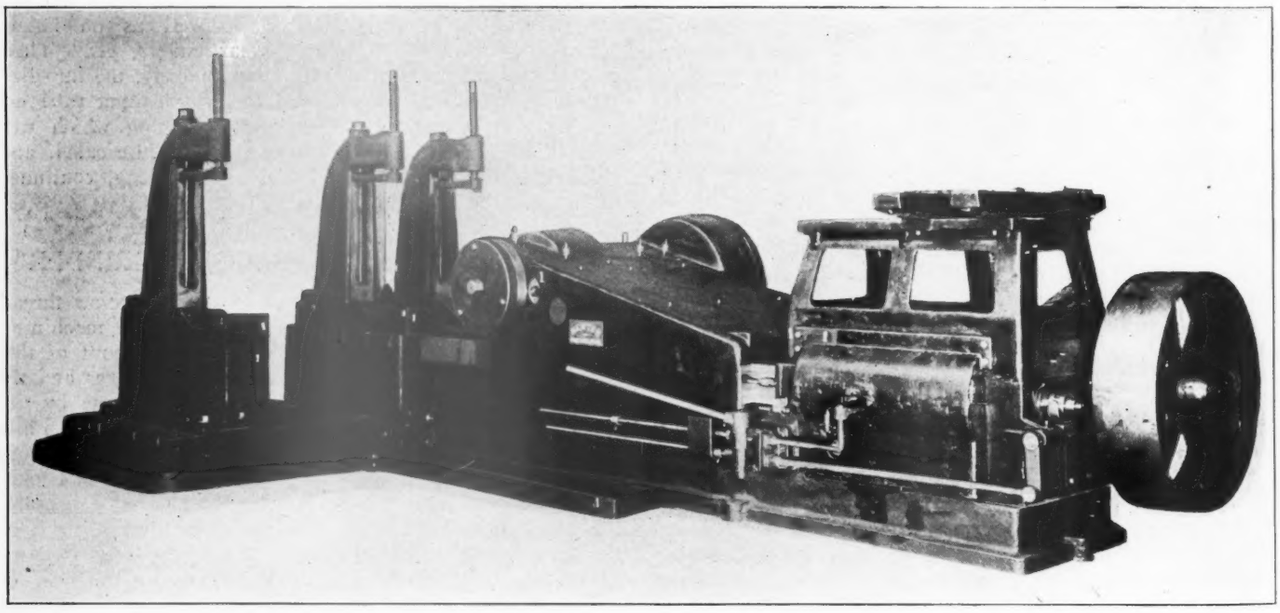
The machines are equipped with individual motors of any specified voltage and either direct or alternating current may be used. The power transmission is accomplished by means of an endless belt indicated, which has a three-point contact with both the driving and driven pulleys, and then travels over a compensating two-pulley arrangement, which automatically keeps it at the proper tension to prevent slipping, and at the same time allows slack enough to prevent loss of power and overheating. The capacity of the machine is limited only by the size of the lathe to which it is attached.

COLD SAW CUTTING-OFF MACHINE

A recent development in cold saw machines for cutting off large ingots and heavy forgings, has been made by the Newton Machine Tool Works, Inc., Philadelphia. This cold saw is equipped with a 76-in. diameter inserted tooth saw blade, which has a capacity for cutting 24-in. diameter stock in one cut. The main work table bolted to the machine base is 56 in. long in the direction of the feed of the saw and 48 in. wide. To this table there is bolted a platen 60 in. long by 56 in. wide by 12 in. deep, with suitable T-slots. On this platen there is a clamping block 18 in. wide at the base and 12 in. wide at the top. This block is in line with the top of the main table referred to above. Two V-blocks are fitted to the main work table and one V-block is fitted to the platen. A swivel arch clamp is supplied for each of the V-blocks, and these are so arranged as to hold work 32 in. in diameter.

The drive of the machine is from a belt-connected motor through a solid bronze worm wheel and hardened steel worm fitted with roller thrust bearings. A spur pinion with teeth cut in the solid shaft transmits the power to the spindle driving gear. The feed motion is taken from the drive shaft through gears to the oil-tight feed box in which the change gears are mounted on a sliding sleeve controlled by latch levers in the cover. From this box the motion is transmitted to the saddle feed screw through a feed worm and worm wheel which is positively clutched.

The control of the machine is from the rear. The forward feed is provided with an automatic stop, and the rapid traverse forward and back also has an automatic stop. The feed and rapid traverse mechanism is enclosed with curtain covers. Positive safety release is provided for each extreme position of the traverse. The oil and chip pan is cast on the base and drains the lubricant back to the reservoir. A loose chip pan is fitted between the tables for draining to the base oil pan.



Powerful Cold Saw Cutting-Off Machine Designed to Use 76-in. Diameter Inserted Tooth Saw

Railway Mechanical Engineer

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with which the AMERICAN ENGINEER *was incorporated)*

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WE GUARANTEE, that of this issue, 12,100 copies were printed; that of these 12,100 copies 11,177 were mailed to regular paid subscribers; 20 were provided for counter and news company sales, 223 were mailed to advertisers, 32 were mailed to employees and correspondents, and 648 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 36,300, an average of 12,100 copies a month.

THE RAILWAY MECHANICAL ENGINEER is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. P. C.).

The Paducah, Ky., roundhouse and shops of the Nashville, Chattanooga & St. Louis, which have been idle since the beginning of the war, are to reopen on March 1.

Employees killed on the railroads of the United States, operated by the government, in the month of November, 1919, numbered 231 and employees injured 10,191, as compared with 359 killed and 11,248 injured in November, 1918. These are the totals shown in Bulletin No. 12, issued by the Safety Section, United States Railroad Administration.

Circular 263 of the Southwestern regional director cites a gasoline fire which resulted in a loss of $8,620, due to the negligence of a car repairer who worked on a leaky tank car with an open flame lantern, in violation of all regulations. The bulletin emphasizes the importance of observing all rules governing the transportation of explosives and other dangerous articles.

The Railroad Administration and the principal railroad companies have adopted the plan which has been reported from time to time as the negotiations have progressed for the financing of the equipment ordered by the Railroad Administration in 1918 by means of individual equipment trusts, payable in 15 annual instalments, with the Guaranty Trust Company of New York as trustee.

An abstract from the Times' Trade Supplement states that the Colombian railways are at present in great need of new rolling stock. In the very near future extensions are to be made, and this will create a demand for locomotives, coaches and freight cars. There will also be a large demand for permanent way materials owing to the reconstruction of large sections of the Colombian railways.

Because of the very disadvantageous rate of exchange, directors of several of the English railroads have issued instructions that no purchases are to be made in America except where it is absolutely impossible to obtain the same products elsewhere. Lines are being drawn more closely day by day against purchases in America by the railways in all European countries, due to the great disparity in the value of money. Furthermore, the railways in every country are making, as never before, every attempt to make purchases within their own frontiers. This will have a serious effect on English business, which relies to such a very great extent on its export business to balance the necessary imports.

New Fuel for French Locomotives

The Paris, Lyons & Mediterranean has decided to adapt 200 of its locomotives to crude oil or Mazout. The modification is expected to be effected at the rate of two engines a day. Reserve tanks will be set up at suitable points on the system to hold between 40 and 100 tons of fuel.

The plant modifications are neither difficult nor costly, being simply a reservoir in place of the coal bunkers, conducting tubes to the burners and refractory bricks in the firebox.

At an official test held at Bercy on November 25, the locomotive drew a heavy goods train on approximately half the weight of fuel which would have been necessary for the work if coal had been used. There is practically no smoke and it is expected that this fuel will save much labor in the enginehouses.

Investigation of Chilled-Iron Car Wheels

It has been noted for several years that failures of chilled cast iron freight-car wheels occur quite frequently at the foot of long and steep grades. The cause of such failure appears to be the heating of the wheel produced by the prolonged application of the brake-shoes, this rise in temperature causing complicated stresses in the structure of the wheel. The stresses thus produced may be sufficient to cause cracking and failure and in all probability a derailment of the car under which the wheel is placed.

In order to determine the exact temperatures in different portions of the wheel, after prolonged heating of the rim, the Bureau of Standards has instituted a complete investigation of this subject. It is obvious that temperature measurements can not readily be made upon a wheel in service, and considerable ingenuity has been shown in perfecting a laboratory apparatus capable of producing conditions analogous to those met with on the road.

Australia Manufacturing Railway Supplies

Several Australian engineering firms have taken up the manufacture of railway supplies, and the Chief Commissioner for Railways, James Fraser, of New South Wales, has expressed complete satisfaction with the local products. He said that he had been pleased to give preference to Australian

manufactures, and he had not had to pay higher prices than for goods of the same quality from foreign sources. The New South Wales railway administration has been making axles, wheels and tires for both freight and passenger cars in its own shops, and shortly everything required for making a locomotive, with the exception of boiler plates and copper tubing and plates, will be made in Australia, and even the latter will be produced in Australia before long. Mr. Fraser said that he had been promised delivery next March of copper tubes by an Australian manufacturer at a slightly lower figure than that for which he could get copper tubes abroad.

The New Zealand government has placed a contract with an Australian shop for 20 express locomotives. This shop has already turned out over £300,000 worth of work, to the complete satisfaction of the New Zealand railways.

Locomotive Building in Belgium

According to a recent report on the subject of locomotive production in Belgium, says the Railway Gazette, London, there were in that country prior to the war 20 factories in which the construction of railway engines was undertaken. The whole of these were damaged very considerably by the German army and most of the plant removed, one factory being completely destroyed. The work so far undertaken since the cessation of hostilities has been limited to the repair of the buildings and plant, and, as far as has been possible, replacement of the shop equipment. The shortage of engines and the poor condition of those available give scope for immedate activity in this branch of industry, but the shortage of fuel, the difficulty of obtaining raw material, etc., want of capital and the exorbitant demands of the workmen, all stand in the way of progress. The total number of workmen at present employed is 4,542, or about 75 per cent of the number employed in 1913, and these are engaged in repairing locomotives for the State and branch railways. The raw material for a few engines on order in 1914 was hidden and escaped the capacity of the invaders, and the completion of these engines, with a construction of a few others, form today all that the Belgium workshops are able to do in the matter of locomotive production.

Changes in Erie Railroad Organization

On the return of the railroads to private control a radical change will be effected in the official personnel of the Erie. The principal feature of the new plan is the establishment of four regions, each, with one exception, consisting of three or more operating divisions. Each of these regions will be placed in charge of a manager who, reporting to the general manager, will be in practically entire charge of all phases of work done in his particular region. With this in mind each regional manager is to have a regional engineer, a mechanical superintendent, a general freight and passenger agent, a superintendent of transportation, a claim agent, an auditor, an assistant treasurer, a storekeeper and a chief of police. The former divisional organization is to be retained and the superintendents of the several divisions will each report to the manager of the region in which they are included.

The general manager's organization is to consist of a general superintendent of transportation, a general mechanical superintendent, a chief engineer, a general storekeeper and an inspector police.

The regional engineer, regional mechanical superintendent, etc., will each report directly to the regional manager, but in order that their work may be properly co-ordinated they will also report indirectly to their respective officers on the general manager's staff or to the other officers at the head of the railroad organization as the case may be.

The four regions will be known as the New York region, Hornell region, Ohio region and Chicago region.

William Schlafge, formerly general mechanical superintendent with office at Meadville, Pa., has been appointed mechanical manager on the general manager's staff, with headquarters in New York.

The four regional mechanical superintendents are as follows: W. S. Jackson, New York region, Jersey City, N. J.; formerly mechanical superintendent of the Lines East, with office in New York. Charles James, Hornell region, Hornell, N. Y.; formerly mechanical superintendent of the Lines West, Youngstown, Ohio. A. G. Trumbull, Ohio region, Youngstown, Ohio; formerly assistant to the general mechanical superintendent, Meadville, Pa. G. T. Depue, Chicago region, Chicago; formerly shop superintendent at Susquehanna, Pa.

Material Specifications for Tank Cars

The Mechanical Section of the American Railroad Association has recently issued Circular S III-92 giving notice that the suspension of the requirement for boiler plate steel, flange quality, for plates of class III tank cars, as authorized by circular No. S III-67, dated October 10, 1919, is hereby extended to continue in effect until April 1, 1920, only.

The material for all plates of tanks of class III tank cars built after that date must comply with section 2 (a) of the specifications for class III tank cars, 1919 edition, page 21, which reads as follows:

"Material—(a) For cars built after April 1, 1920, all plates for tank and dome shall be of steel complying with the American Society for Testing Materials specifications for boiler plate, flange quality."

The tank car specifications, as revised 1919, effective February 1, 1920, are now ready for distribution, and will be supplied at the following prices to members of the association: 100 copies or more $15 per 100; 50 copies $8; less than 50 copies, each 25 cents.

W. H. Woodin Says Railways Need 849,500 Cars

William H. Woodin, president of the American Car & Foundry Company, has made an investigation, as a result of which he estimates that the railroads of the United States will need 849,500 cars during the next three years. It is Mr. Woodin's opinion that while this need, if it is supplied, will run into a tremendous amount of money, the railroads will begin to renew their equipment once the carriers have been returned to private ownership, and that the money will be forthcoming to finance the undertaking. Unless measures to increase the efficiency of the railroads are consummated, he considers that there may be a serious interference with the normal ebb and flow of business. He draws attention to the fact that even now some factories have closed because, due to the car shortage, they cannot get materials.

To make up the present apparent shortage it is asserted 240,000 cars are needed. Replacement for retirement through the next three years will require 234,300 cars, and to take care of increased business it is estimated that 375,200 cars will be needed in the three-year period. The replacement figure is on the basis of an average retirement of 3½ per cent a year and the increased business on 5 per cent a year.

The following table shows the requirements for replacement and increased business during the three years:

	Replacement	To handle increased business
1920	73,500	118,500
1921	78,000	125,000
1922	82,800	131,700

These requirements, Mr. Woodin believes, are not beyond the capacity of the car builders of the country, but it is believed that under the present adverse conditions regarding purchase of steel and other materials it would not be possible to turn out more than 600,000 cars, or some 200,000 a year.

Electrical Workers Strike on St. Paul

Chicago, Milwaukee & St. Paul shopmen employed in the shops at Deer Lodge, Mont., recently engaged in an unauthorized strike because of a desire to force a decision in matters pending before the arbitration board at Washington.

As a direct result of the difficulty practically the whole electrified division of the St. Paul, extending from Harlowton, Mont., to Avery, Idaho, was operated with great difficulty. Federal officers of the road, on hearing of the strike of the shopmen, requested them to await arbitration. However, the shopmen refused, and 48 hours later the electrical sub-station operators on practically the whole electrically-operated division walked out in sympathy with the shopmen. Electrical experts and officers of the electrified division took the places of the sub-station operators as far as possible, and in many places on the division it was found necessary to use steam to maintain service. Director General Hines was immediately notified, and after stating that the sub-station operators' strike was in violation of their contract, issued a 48-hour ultimatum, and the men acceded to his request and returned on February 5. Approximately 300 shopmen and 40 sub-station operators were involved. During the strike some through passengers were detoured over the Northern Pacific.

Reorganization of the Pennsylvania System

The Pennsylvania System has been reorganized for operating purposes after March 1, and has been divided into four regions.

System officers have been grouped under an executive department having attached thereto a transportation department, a traffic department, a financial department, an accounting department, a purchasing department, a real estate department, a legal department, an insurance department, an employees' saving fund department, and a relief and pension department. Samuel Rea will, of course, be president, and reporting directly to him there will be a vice-president in charge of operation, W. W. Atterbury; a vice-president in charge of traffic, George W. Dixon; a vice-president in charge of accounting, A. J. County; a vice-president in charge of real estate, purchases and insurance, M. C. Kennedy; a vice-president in charge of corporate work at Pittsburgh, James J. Turner. There will be two secretaries, one at Philadelpiha, Lewis Neilson, and one at Pittsburgh, S. H. Church. In addition there will be a vice-president in charge of personnel, G. L. Peck, who will report to Gen'l. Atterbury.

The combined lines east and west of Pittsburgh have been divided into four sections: The eastern, from New York to Altoona, Pa., and Washington, D. C.; the central, from Altoona to Buffalo, N. Y., Columbus, Ohio, and Mansfield; the northwestern, from Columbus and Mansfield to Chicago; and the southwestern, from Columbus and Cincinnati to St. Louis, Mo. Each of these will be in charge of a regional vice-president. The four regional vice-presidents are Elisha Lee at Philadelphia, R. L. O'Donnel at Pittsburgh, J. G. Rodgers at Chicago, and Benjamin McKeen at St. Louis.

Each regional vice-president will have on his staff a general manager, a general superintendent of transportation, a chief engineer of maintenance of way, a general superintendent of motive power, general superintendents, a traffic manager, a purchasing agent, a real estate agent, and an accountant. On the eastern and central regions there are assistants to the general manager, general superintendents of transportation, etc., commensurate with the amount of business to be handled by the region.

The transportation department, headed by General Atterbury, will consist of a chief of transportation, C. M. Sheaffer, at Philadelphia, with assistants; a chief of motive power, J. T. Wallis, at Philadelphia; a chief mechanical engineer, A. W. Gibbs, at Philadelphia; an engineer of transportation, E. W. Smith, at Philadelphia, and a chief engineer, A. C. Shand, at Philadelphia, with a considerable staff of assistants.

The relations between the central organization and the regional organizations is particularly interesting and constitutes an entirely new departure for the Pennsylvania, although some features of it were inherent in the Harriman system of roads, as this system was being developed at the time of E. H. Harriman's death. It will be remembered that Mr. Harriman had a director of operation for the entire Harriman system. W. W. Atterbury, with the title of vice-president in charge of operation, might well have been designated director of operation. While each regional vice-president is responsible for traffic, maintenance and operation in his territory, General Atterbury's duties consist of coordinating the work of these officers in regard to both operation and maintenance. His supervision will therefore be more comprehensive than a mere setting of system standards. This is true also of the executive vice-presidents in charge of traffic, finance, accounting and purchases. While the regional vice-presidents have on their staff traffic and purchasing officers they can also avail themselves of the vice-presidents at Philadelphia as consulting experts.

The Altoona shops will be in charge of a works manager, P. F. Smith, Jr., with a shop accountant, an assistant chief of motive power (car), an assistant chief of motive power (locomotive), and a motive power accountant. In other words, the Altoona shops will be organized in much the same way as is an industrial manufacturing plant.

The following list gives the names of mechanical department officers their new titles, positions and headquarters.

SYSTEM OFFICERS

Name	*Title*	*Headquarters*
J. T. Wallis	Chief of motive power (formerly gen. supt. motive power, Altoona)	Philadelphia
P. F. Smith, Jr.	Works manager (formerly gen. supt. motive power, Lines West, Pittsburgh)	Altoona
J. R. Black	Shop accountant	Altoona
R. L. Kleine	Asst. chief of mot. pwr. (car) (formerly chief car inspector, Altoona)	Altoona
F. W. Hankins	Asst. chief mot. pwr. (loco.) (formerly master mechanic, Altoona)	Altoona
G. M. Ellsworth	Motive power accountant	Altoona
A. W. Gibbs	Chief mechanical engineer	Philadelphia
E. W. Smith	Engineer of transportation (formerly supt. motive power, Cent. Div., Williamsport)	Philadelphia

EASTERN REGION

J. M. Henry	General supt. motive power (formerly asst. gen. supt. motive power, Altoona)	Philadelphia
Eliot Sumner	Supt. motive power, N. J. div.	New York

RAILROAD CLUB MEETINGS

Club	Next Meeting	Title of Paper	Author	Secretary	Address
Canadian	Mar. 9	Locomotive Valve Motion	F. Williams	W. A. Booth	131 Charron St., Montreal, Que.
Central	Mar. 12	The Labor Situation Today and Tomorrow	F. H. Hardin	H. D. Vought	95 Liberty St., New York.
Cincinnati	May 11			H. Boutet	101 Carew Building, Cincinnati, O.
New England	Mar. 9	Annual Meeting and Entertainment		W. E. Cade, Jr.	683 Atlantic Ave., Boston, Mass.
New York	Mar. 19	The Automatic Stop Problem	H. S. Balliet	H. D. Vought	95 Liberty St., New York.
Pittsburgh	Mar. 26			J. D. Conway	515 Grandview Ave., Pittsburgh, Pa.
St. Louis	Mar. 12			B. W. Frauenthal	Union Station, St. Louis, Mo.
Western	Mar. 15			J. M. Byrne	916 West 78th St., Chicago.

C. B. Keiser.....Supt. mot. pwr., E. Pa. div....Harrisburg
(formerly supt. motive power at Wilmington, Del.)
Amos Davis.....Supt. mot. pwr., Southern div..Wilm'gton, Del.
(formerly master mechanic, Wilmington, Del.)
Robert Bennett...Supt. mot. pwr., Cent. Pa. div..Williamsp't, Pa.

CENTRAL REGION

H. H. Maxfield...Gen. supt. motive power.....Pittsburgh
(formerly works manager, Altoona)
C. L. McIlvaine...Supt. mot. pwr., Northern div..Buffalo
J. L. Cunningham..Supt. mot. power, W. Pa. div..Pittsburgh
E. B. DeVilbiss...Supt. mot. power, E. Ohio div..Pittsburgh
(formerly asst. eng. motive power, Pittsburgh)
W. Y. Cherry.....Supt. motive power, Lake div..Cleveland
(formerly master mech., Grand Rapids & Indiana, Grand Rapids)

NORTHWESTERN REGION

T. W. Demarest..Gen. supt. motive power.....Chicago
(formerly supt. motive power, Northwest System, Pittsburgh)
O. C. Wright.....Supt. motive power, Ill. div...Ft. Wayne, Ind.
(formerly supt., Central System, Cambridge, O.)
O. P. Reese.....Supt. mot. power, N. Ohio div..Toledo, O.

SOUTHWESTERN REGION

W. C. A. Henry...Gen. supt. motive power.....St. Louis
(formerly supt. motive power, Columbus, O.)
J. E. Mechling....Supt. mot. power, Indiana div..Indianapolis
(formerly supt. motive power, St. Louis System, Indianapolis)
G. B. Fravel.....Supt. mot. pwr., Cent. O. div..Columbus, O.
(formerly master mechanic, Southwest system, Columbus)

PURCHASING DEPARTMENT

Samuel Porcher...General purchasing agent.....Philadelphia

EASTERN REGION

Mont. Smith.....Purchasing agent.....Philadelphia
H. A. Anderson...Asst. purchasing agent.....Philadelphia
B. P. Philippe....Asst. purchasing agent.....Philadelphia
D. T. Jones.....Asst. to the purchasing agent..Philadelphia

CENTRAL REGION

W. G. Phelps.....Purchasing agent.....Pittsburgh
C. E. Walsh.....Asst. purchasing agent.....Pittsburgh

NORTHWESTERN REGION

J. B. Thomas.....Purchasing agent.....Chicago
Henry Sullivan...Asst. purchasing agent.....Chicago

SOUTHWESTERN REGION

C. R. Peddle.....Purchasing agent.....St. Louis

MEETINGS AND CONVENTIONS

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations:

AIR-BRAKE ASSOCIATION.—F. M. Nellis, Room 3014, 163 Broadway, New York City. Convention May 4-7, Hotel Sherman, Chicago.

AMERICAN RAILROAD ASSOCIATION, SECTION III.—MECHANICAL.—V. R. Hawthorne, 431 South Dearborn St., Chicago. Convention, June 9-16, 1920, Atlantic City, N. J.

AMERICAN RAILROAD MASTER TINNERS' COPPERSMITHS' AND PIPEFITTERS' ASSOCIATION.—O. E. Schlink, 485 W. Fifth St., Peru, Ind.

AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—R. D. Fletcher, Belt Railway, Chicago.

AMERICAN SOCIETY FOR TESTING MATERIALS.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa. Annual meeting, June 21, 1920, New Monterey Hotel, Asbury Park, N. J.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Calvin W. Rice, 29 W. Thirty-ninth St., New York.

AMERICAN STEEL TREATERS' SOCIETY.—W. H. Eisenman, 154 E. Erie St., Chicago.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—Aaron Kline, 626 North Pine Ave., Chicago. Meetings second Monday in month, except June, July and August, Hotel Morrison, Chicago.

CAR FOREMEN'S ASSOCIATION OF ST. LOUIS.—Thomas B. Koeneke, secretary, Federal Reserve Bank Building, St. Louis, Mo. Meetings first Tuesday in month at the American Hotel Annex, St. Louis.

CHIEF INTERCHANGE CAR INSPECTORS' AND CAR FOREMEN'S ASSOCIATION.—H. J. Smith, D. L. & W., Scranton, Pa.
J. C. Keene, Decatur, Ill.

INTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION.—A. L. Woodworth, C. H. & D., Lima, Ohio.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—J. G. Crawford, 542 W. Jackson Blvd., Chicago. Convention, May 24-27, 1920, Hotel Sherman, Chicago, Ill.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—William Hall, 1061 W. Wabasha Ave., Winona, Minn.

MASTER BOILERMAKERS' ASSOCIATION.—Harry D. Vought, 95 Liberty St., New York. Convention May 25-28, Curtis Hotel, Minneapolis, Minn.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION OF U. S. AND CANADA.—A. P. Dane, B.&M., Reading, Mass.

NIAGARA FRONTIER CAR MEN'S ASSOCIATION.—George A. J. Hochgrebe, 623 Brisbane Bldg., Buffalo, N. Y. Meetings, third Wednesday in month, Statler Hotel, Buffalo, N. Y.

RAILWAY STOREKEEPERS' ASSOCIATION.—J. P. Murphy, Box C, Collinwood, Ohio.

TRAVELING ENGINEERS' ASSOCIATION.—W. O. Thompson, N. Y. C. R. R., Cleveland, Ohio.

PERSONAL MENTION

GENERAL

C. D. KINNEY, master mechanic on the Boyne City, Gaylord & Alpena, with office at Boyne City, Mich., has been promoted to superintendent of motive power, with the same headquarters. Mr. Kinney was born on August 25, 1876, at Conneaut, Ohio, and attended Conneaut High School. He took employment with the New York, Chicago & St. Louis in November, 1896, as a machinist apprentice, later working as a machinist on that road and on the Southern, the Central of Georgia and the Seaboard Air Line. From November, 1902, to April, 1908, he was general foreman of the Seaboard Air Line at Fernandina, Fla. He was then general foreman of the Kanawha & Michigan at Middleport, Ohio, and in May, 1910, was appointed master mechanic there. In November, 1912, he went to the Chicago & Alton, as general foreman at Roodhouse, Ill., remaining there until November, 1913, when he became enginehouse foreman of the Baltimore & Ohio at Pittsburgh, Pa., and later at Holloway, Ohio. From November, 1915, to October, 1916, he was master mechanic for the Robert Grace Contracting Company, Pittsburgh, Pa., and then went to the New York, Chicago & St. Louis as machine shop foreman at Conneaut, Ohio. In October, 1919, he became master mechanic of the Boyne City, Gaylord & Alpena at Boyne City, Mich., and in January, 1920, was appointed to his present position of superintendent of motive power.

C. D. Kinney

CHARLES BOND, mechanical engineer of the Erie, with office at Meadville, Pa., has been appointed general foreman of the centralizing plant, succeeding George W. Armstrong, resigned.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

J. E. BROGDEN, whose appointment as superintendent of the Waycross, Ga., shops of the Atlantic Coast Line was announced in the February issue, was born on March 10, 1876, at Sumter, S. C., and attended Clemson Agricultural & Mechanical College from 1893 to 1895. His entire railroad service has been with the Atlantic Coast Line, having entered its employ as a machinist apprentice in 1896. In 1903 he was promoted to the position of roundhouse foreman at Florence, S. C., and was appointed general foreman on April 1, 1904. On April 1, 1906, he was transferred to Savannah, Ga., and about a year later to Montgomery, Ala. On January 1, 1918, he was appointed master mechanic at Montgomery, and on August 1, 1918, was transferred to Waycross, Ga., as master mechanic of the Waycross and Savannah districts.

C. H. CHAMBERS, road foreman of engines on the Atchison, Topeka & Santa Fe, has been appointed assistant air

brake instructor, with jurisdiction over the Western, Arkansas River, Colorado and New Mexico divisions, with headquarters at La Junta, Colo., succeeding M. O. Davis, who has resigned to accept a position with the Westinghouse Air Brake Company at Topeka, Kan.

R. R. HERRICK has been appointed master mechanic of the Detroit, Bay City & Western and the Port Huron Southern at Bay City, Mich.

I. B. IRVIN, general foreman of the Pittsburgh, Shawmut & Northern at Angelica, N. Y., has been appointed master mechanic without change of headquarters, and the position of general foreman has been abolished.

LOUIS METZGER, chief inspector at the Jersey City, N. J., roundhouse of the Erie, has been promoted to the position of roundhouse foreman.

W. N. MITCHELL, formerly master car builder on the Missouri, Kansas & Texas, and who for the past five years has been engaged in government valuation work, has been appointed superintendent of the car department of the Missouri, Kansas & Texas, with headquarters at Denison, Tex.

F. H. MOORE has been appointed assistant master mechanic of the Maritime district of the Canadian National Railways, with headquarters at Moncton, N. B.

ARTHUR L. ROBINSON, assistant to the general superintendent of the Wabash, with headquarters at St. Louis, Mo., has been appointed to a newly created position in which he will supervise the adjustment of controversies between the management and the employees.

GEORGE SEARLES has been appointed master mechanic of the Arizona division of the Atchison, Topeka & Santa Fe, with headquarters at Needles, Cal., succeeding Charles Raitt, assigned to other duties.

J. P. STEWART has been appointed road foreman of engines of the Atchison, Topeka & Santa Fe, with jurisdiction over the Second and Third districts of the New Mexico division, with headquarters at Las Vegas, N. M., succeeding C. H. Chambers.

SHOP AND ENGINEHOUSE

JAMES M. COBLE has been appointed shop superintendent of the Buffalo, Rochester & Pittsburgh at Rikers, Pa., succeeding W. W. Scott, resigned.

OBITUARY

GEORGE LINDSAY, formerly master mechanic of the Evansville, Ind., shops of the Evansville & Terre Haute, died in that city on January 24, aged 69 years.

EDWARD P. RIPLEY, chairman of the board of directors and formerly president of the Atchison, Topeka & Santa Fe, and one of the greatest railroad executives America has produced, died in Santa Barbara, Cal., on February 4, as the result of complications following an operation performed several months ago. Mr. Ripley was born at Dorchester, Mass., on October 30, 1845. He began railway work in 1868 as contracting agent for the Star Union Line at Boston, Mass. From October, 1870, to 1872, he was clerk to the general eastern agent of the Chicago, Burlington & Quincy, and from the latter date to 1875 he was New England agent. He then became general eastern agent, and on June 15, 1878, was made general freight agent. He held the latter position until 1887, when he was appointed traffic manager, and the following year he was promoted to general manager of the Burlington. In August, 1890, he was chosen third vice-president of the Chicago, Milwaukee & St. Paul, which position he held until he became president of the Santa Fe on January 1, 1896.

SUPPLY TRADE NOTES

The Conley Car Company, Pittsburgh, Pa., has changed its name to the Conley Tank Car Company.

E. C. Middleton has been appointed advertising manager of the Colburn Machine Tool Company, Franklin, Pa.

Theodore L. Dodd & Co., Chicago, have been appointed district sales representatives for the Titusville Forge Company, Titusville, Pa.

Samuel M. Vauclain, president of the Baldwin Locomotive Works, Philadelphia, has returned to this country after a brief visit to Europe.

C. E. Bransfield, foreman for the Standard Car Construction Company, Masury, Ohio, has been promoted to general superintendent.

The capital stock of the Highland Iron & Steel Company, Terre Haute, Ind., has been purchased by the American Chain Company, Inc., New York.

Frederick W. Renshaw, president of the Globe Seamless Steel Tubes Company, Chicago, died on February 1 at his home in Evanston, Ill., at the age of 39 years.

Donald S. Linton has joined the Warner & Swasey Company, Cleveland, Ohio, having formerly been connected with the Pratt & Whitney Company, Hartford, Conn.

Frank A. Turner, chief engineer of the Becker Milling Machine Company, Hyde Park, Mass., has become chief engineer of the Flexible Automotive Tire Company, Boston.

Charles E. Hildreth, president and general manager of the Whitcomb-Blaisdell Machine Tool Company, Worcester, Mass., has been elected president of the Worcester chamber of commerce.

Harold M. Davis, manager of the advertising department of the Sprague Electric Works of the General Electric Company, New York, died at his home in Brooklyn on February 9, 1920.

Arnold J. Burke, for 16 years connected with the United States armory in Springfield, Mass., has been appointed employment manager of the Greenfield Tap & Die Corporation, Greenfield, Mass.

George W. Diehl, president of the Cincinnati Shaper Company, Cincinnati, Ohio, has sailed for England and France, to establish branches through which the company's foreign business will be handled.

G. C. Cook, general sales manager of the Warner & Swasey Company, has left for a five weeks' trip through the South and to the Pacific coast. He expects to visit about 50 cities and towns before returning.

The Gardner-Bryan Company, Cleveland, Ohio, has been appointed special representative in Ohio, Indiana and Western Pennsylvania for the Precision and Thread Grinder Manufacturing Company, Philadelphia, Pa.

C. B. Ferry, vice-president of the Chicago, Milwaukee & St. Paul, has been elected a director of the Associated Welding Companies, Inc., New York, a corporation formed recently by thirteen electric welding companies.

William R. Mau, general superintendent of the Rich Tool Company, Chicago, has been appointed Chicago district manager of the Vanadium-Alloys Steel Company, Pittsburgh, Pa., with offices at 566 West Randolph street, Chicago.

F. H. Maple, superintendent of the Point St. Charles (Que.) plant of the Canadian Steel Foundries, Ltd., Montreal, Que., has been appointed foundry superintendent of the American Steel Foundries' plant at Alliance, Ohio.

The Sherritt & Stoer Company, Inc., Philadelphia, Pa., announces the opening of new offices, storeroom and warehouse at 2006-8 Market street, where it will maintain a permanent exhibition of machine tools, railway and machine shop equipment.

The Westinghouse Electric & Manufacturing Company has filed plans for the erection of a machine shop, 1,000 ft. long by 100 ft. wide, on Page boulevard, Springfield, Mass., to cost $250,000. The building will be of brick, concrete and steel, of the saw-tooth type.

William R. Gummere, who for a number of years represented the Independent Pneumatic Tool Company, of Chicago, in Cleveland, Ohio, has again become affiliated with that company at the Pittsburgh branch, which is under the management of Harry F. Finney.

J. A. McLennan, general superintendent of the Link-Belt Company, Philadelphia, Pa., has resigned to become general manager of the McDonough Manufacturing Company, Eau Claire, Wis., which has recently been reorganized and is now manufacturing machine tools.

Howard C. Rose, 827 Ford building, Detroit, representative of the Ingersoll Milling Machine Company, Rockford, Ill., and the Foote-Burt Machine Company, Cleveland, will make an extended tour through Europe in the interests of these companies, for purposes of trade investigation.

Alexander MacDonald Graver, vice-president of the Graver Corporation, East Chicago, Ind., died at his home in Chicago on January 31. Mr. Graver was one of five brothers who control the Graver Corporation, formerly the Wm. Graver Tank Works. He was born at Pittsburgh, Pa., on May 15, 1883, and was educated at the University of Michigan, from which institution he graduated in 1905. He then entered the engineering department of the Wm. Graver Tank Works, where he had charge of the electrical and steam equipment and remodeled the company's manufacturing plant. In 1908 he entered the purchasing department and soon after assumed charge of the purchase of steel plates. From 1910 to the time of his death, Mr. Graver was identified with the sales department of the organization and for the past two years has been virtually sales manager, although holding the title of vice-president of the organization.

A. M. Graver

L. R. Meisenhelter has been appointed special representative of the Houston, Stanwood & Gamble Company, Cincinnati, Ohio, and will devote his entire time to the sale of this company's line of lathes. Mr. Meisenhelter has disposed of his interest in the L. R. Meisenhelter Machinery Company.

The Plant Engineering & Equipment Company, Inc., New York, manufacturers of the Corliss valve steam trap and other power and heating specialties, announces the opening of an office at 282 South Ferry street, Newark, N. J. M. Wm. Ehrlich has been made New Jersey manager, with a sub-office at Lyndhurst, N. J.

Oscar Nordstrom, formerly district manager of the Norton Company, Worcester, Mass., with headquarters in Cincinnati, is at present taking a training course in the machine division at the Worcester works. H. W. Lehman, Cleveland, has been transferred to Cincinnati to take over the former duties of Mr. Nordstrom.

E. E. Griest, notice of whose appointment as general superintendent of the Chicago Railway Equipment Company, Chicago, appeared in the January issue, was born at Zanesville, Ohio, on November 28, 1882. He entered railway service in 1899 as a clerk in the auditors' office of the Cleveland & Marietta at Cambridge, Ohio. In 1900 he entered the employ of the Pittsburgh, Cincinnati, Chicago & St. Louis as an apprentice machinist in the Columbus (Ohio) shops, remaining in this capacity and later as a machinist until November, 1904, when he entered Purdue University, graduating in 1907. After some time spent in Alaska, he returned to the United States in 1907 as a designer in the engineering department of the Crucible Steel Company of America, Pittsburgh, Pa. In 1908 he was appointed foreman in the Hornell (N. Y.) shops of the Erie and later in the same year he was appointed assistant machine shop foreman in the Fort Wayne (Ind.) shops of the Pennsylvania Lines West. On March 15, 1909, he was promoted to assistant master mechanic, with the same headquarters, and in January, 1915, he was promoted to master mechanic. He retained this position until 1918, when he resigned to become connected with the Chicago Railway Equipment Company, with headquarters at Chicago. In September, 1918, he was transferred to Detroit, Mich, remaining there until his recent promotion.

E. E. Griest

Frank R. Bacon, president of the Cutler-Hammer Manufacturing Company, Milwaukee, Wis., has been elected chairman of a new organization in Milwaukee known as the American Constitutional League, the activities of which will be confined solely to Americanization work and which will embrace all forms of education and publicity in favor of Americanization.

F. Rodger Imhoff, New England representative of the Precision & Thread Grinder Manufacturing Company, Philadelphia, has been appointed field engineer, with headquarters in Detroit, covering the entire country in the interest of the multi-graduated precision grinder. Mr. Imhoff is an expert in thread grinding and has written many papers on that subject.

Arthur G. Henry, metallurgist for the Illinois Tool Works and secretary of the American Steel Treaters' Society since its organization in September, 1918, has resigned from both offices to become special representative for the Vanadium Alloys Steel Company, Latrobe, Pa., with offices at 566 W. Randolph street, Chicago. Mr. Henry has been succeeded

on the board of directors of the American Steel Treaters' Society by W. H. Eisenman, business manager of the society, who in addition also succeds him as secretary, combining the two offices with the title of executive secretary.

The Booth Electric Furnace Company, Chicago, announces the opening of two new sales offices in addition to the regular district offices already established. One is at Detroit, 805 Hammond building, and is in charge of M. A. Beltaire, Jr.; the other is at Birmingham, Ala., located in the Brown and Marx building, and is in charge of Cassman & Cunningham.

The Imperial Belting Company, Chicago, has opened a special railroad sales department under the direction of A. G. Pickett as general manager and the following have been appointed sales engineers: Edward H. Willard, David L. Jennings and William D. Otter, all formerly with the H. W. Johns-Manville Company; William G. Willcoxen, formerly associated with the Boss Nut Company, Chicago, and Edward A. Woodworth, formerly secretary of the Committee on Standards for Locomotives and Cars of the United States Railroad Administration. A new office has been opened in the Merchants' National Bank building, St. Paul, Minn., in charge of Blake C. Hooper. A. G. Pickett was born at New London, Mo., on July 12, 1888. In 1911 he became connected with the sales department of the National Refining Company, Hannibal, Mo. Later in the same year he was appointed special power plant representative for the H. W. Johns-Manville Company at New York. On January 1, 1916, he was promoted to assistant manager of the power specialties department and in 1917 was promoted to manager of that department, which position he retained until August, 1919, when he resigned to become connected with the sales department of the Imperial Belting Company.

A. G. Pickett

The Hauck Manufacturing Company, Brooklyn, N. Y., announces the removal of the Pittsburgh office of the Hauck Burner Service Station from 2930 Penn avenue to 105 Wood street. The Boston and Cleveland service stations have also been moved to larger quarters, the former from 70 High street to 149 Berkeley street, and the Cleveland office from 2114 Superior viaduct to 1106 Walnut avenue.

A. A. Blue has been placed in charge of the heat treating department of the Duff Manufacturing Company, Pittsburgh, Pa. Mr. Blue is a graduate of the chemical engineering department of Cornell University. For two years he was connected with the Midvale Steel Company in the heat treating department, and during the war served as assistant superintendent of heat treating and forge shop in the gun plant of the Watertown arsenal.

The American Chain Company, Bridgeport, Conn., has purchased the control of the Page Steel & Wire Company, with mills at Monessen, Pa., and Adrian, Mich., and the business will be continued as heretofore. The new officers elected under the reorganization of the company are Walter B. Lashar, president; William T. Morris, vice-president; Wilmot F. Wheeler, treasurer; John E. Carr, assistant treasurer, and William M. Wheeler, secretary. E. C. Sattley, general manager of the Page Steel & Wire Company, will continue in that capacity with office in Pittsburgh, Pa.

C. N. Kell, has been appointed assistant to the general manager of the forge department of the Duff Manufacturing Company, Pittsburgh, Pa., manufacturer of lifting jacks. For the last eight months he has been assistant to the general superintendent of this company in charge of efficiency work. Mr. Kell designed the equipment of the Rock Island arsenal for testing the recoil mechanism of the French 75-mm. gun. His previous experience included work as mechanical engineer with the Mandel Corporation of Chicago, and an assistant superintendent of the Denny Tractor Company, Cedar Rapids, Iowa.

F. J. Mawby, who was formerly connected with the sales force of Manning, Maxwell & Moore, Inc., and located at the New York office for a number of years, severed his connection with that company on February 1, 1920, and is now a member of the sales organization of the Cincinnati Shaper Company and the Cincinnati Gear Cutting Machine Company, Cincinnati, Ohio. During the war Mr. Mawby did a great deal of engineering work in connection with equipping shops for the manufacture of ammunition, guns and gun carriages for both the United States and foreign governments, and was responsible for the development of a number of special machines for the rapid production of time and high explosive fuses.

B. G. Koether has been appointed vice-president of the Hyatt Roller Bearing Company, Detroit, Mich., in entire charge of the company's sales and advertising departments. At present located at Detroit, Mr. Koether will leave in a short time for Harrison, N. J., there to establish headquarters and take up his new duties. Mr. Koether entered the employ of the Hyatt Roller Bearing Company 18 years ago as accountant and in a short time was promoted to the position of purchasing agent. He was made assistant sales manager at Harrison, N. J., and in 1910 went to Detroit to assume the duties of sales manager. Later he became the head of the motor bearings division and for several years past has been a director of the company. Mr. Koether is a member of the Detroit Board of Commerce and the Detroit Section of the Society of Automotive Engineers.

B. G. Koether

The Williams-Hayward Company has been incorporated at Chicago for the manufacture of varnishes, enamels and paint specialties. LeRoy A. Williams, for 21 years associated with the railroad department of the Flood & Conklin Company, Newark, N. J., is president of the new company and Oscar C. Hayward, for 18 years manager of railroad sales of the Tousey Varnish Company, Chicago, is vice-president. Otto Woldt has been appointed head of the manufacturing department and Max Huhnholz superintendent of the enamel and paint specialties department. The company has purchased a modern varnish factory with a capacity of approximately 500,000 gal. of varnish annually, to which complete mills for the manufacture of enamels and

paint specialties have been added. The main offices and plant are located at 2526 West Van Buren street, Chicago.

Westinghouse Air Brake Company

Joseph R. Ellicott on January 1, 1920, retired as eastern manager of the Westinghouse Air Brake Company, but has been retained by the company in a consulting capacity. He has been succeeded as eastern manager by Charles R. Ellicott, as briefly noted in the January issue. Mr. Ellicott was born in Chicago on November 13, 1881. He received his early education in the public schools of New York, and was graduated from Yale-Sheffield School in 1902. The same year he entered the employ of the Westinghouse Air Brake Company, at Wilmerding, Pa., as special apprentice. After serving two years in the engineering and commercial departments, he was made representative in the New York office, covering both commercial and engineering work. In 1913 he was made assistant eastern manager of the Westinghouse Air Brake Company and the Westinghouse Traction Brake Company. On January 1, 1920, Mr. Ellicott was made eastern manager of both companies.

Robert Burgess has been promoted to southeastern manager, with office in Washington, D. C. He was born in New Haven, Conn., and attended public school there, graduating from grammar and high schools. He began railway service with the Louisville & Nashville under the late Pulaski Leeds as machinist apprentice. On completion of his apprenticeship course he continued with the company in the various capacities of air brake repairman, roundhouse foreman, locomotive fireman and engineer, and general air brake inspector. He joined the Westinghouse Air Brake Company organization in 1893 as assistant instructor in the company's air brake instruction car. In 1896 he was assigned to the southern district, with headquarters at Atlanta, Ga., and for several years at Richmond, Va. He has since that time represented the company continuously in that district as mechanical inspector and commercial representative.

Carl H. Beck has been appointed assistant eastern manager at New York. He was born in Butler, Pa., and was graduated with the class of 1905 in mechanical engineering from Pennsylvania State College. The same year he entered the special apprenticeship course prescribed by the Westinghouse Air Brake Company. He was a specialist on the introduction of the ET locomotive brake equipment, personally superintending the installation of this equipment on some of the first locomotives to be so equipped at the Baldwin and American Locomotive Works. In 1910 he was made commercial representative in the electric railway field, becoming prominently identified in the development and introduction of the safety car equipment. Mr. Beck's study of electric railway operation has made him an authority on transportation problems.

John B. Wright has been promoted to assistant district manager in charge of the Pittsburgh office district. He was born on July 27, 1857, in Pleasantville, Pa., and received his education in the public schools there and at Central State Normal School, Lock Haven, Pa., graduating in 1896. He worked for about 18 months with the Cambria Steel Company, at Johnstown, Pa. In February, 1899, he entered the service of the Westinghouse Air Brake Company, at Wilmerding, Pa., as a clerk in the engineering department. After serving for some time as chief clerk in that department, he was transferred to the general office in charge of engineering correspondence, and later was made assistant to the vice-president. In May, 1919, he was appointed assistant southeastern manager.

A. K. Hohmyer has been promoted to the position of assistant western manager, Chicago, Ill. He was born in Pittsburgh, Pa., and attended the public schools of that city. In February, 1901, he started to work for the Westinghouse Air Brake Company, in the general office, as office boy. He passed rapidly and successively to the order department, engineering department, and other departments until February, 1909, when he was traneferred to the Chicago office as office manager. He remained in that position until 1913, when he was appointed commercial representative. He continued to work in that capacity until January 1, 1920, the time of his promotion to assistant western manager.

William G. Kaylor has been promoted to representative of the newly organized export department of the Westinghouse Air Brake Company, with headquarters in New York. He was born in Indianapolis, Ind., attending public school there and graduating from the Manual Training High School. He graduated from Purdue University in 1905, and entered the employ of the Westinghouse Air Brake Company at Wilmerding, Pa., as a special apprentice. The first year he served in the experimental and engineering departments, and the following year in field work, covering the equipment of electric locomotives for the New York Central at the various building plants throughout the east. He also installed the first air brake equipment on the all-steel passenger cars in interurban New York City service. He acted as mechanical expert in connection with the introduction of electric service on the main lines of both the New York Central and New York, New Haven & Hartford railroads. After serving as assistant for several months to the resident engineer, he became actively engaged in November, 1911, in commercial work, specializing in the traction brake field.

C. R. Ellicott

Robert Burgess

F. H. Parke

F. H. Parke, resident engineer, southeastern district, has been promoted to general engineer, with office at Pittsburgh, Pa. He was born in 1869 at Waterloo, N. Y., and was educated in the public schools at Binghamton, N. Y., and St. John's School, Manlius, where he prepared for a course at Cornell University. He was graduated from Cornell in mechanical engineering in 1892, and immediately entered the service of the Westinghouse Machine Company at Pittsburgh, Pa., first as draftsman and afterwards as engineer of tests. In 1898 he took service with the Westinghouse Air Brake Company, spending the first four years in Petrograd, assisting in the installation of the Westinghouse Air Brake plant being erected there to handle the Russian railway business. Returning to the home office at Wilmerding, Pa., he was given charge of the publicity department and afterwards was made industrial engineer, in which capacity he served until 1911. He was then made resident engineer of the southeastern district.

T. W. Newburn, assistant resident engineer, southern district, at Pittsburgh, has been promoted to district engineer of the southeastern district, with office at Washington, D. C. Mr. Newburn was born near Hoopston, Ill., and received his early education in the country schools and at Greer College. He was graduated from Purdue University with the 1902 class in mechanical engineering, and immediately entered the service of the Cambria Steel Company, Johnstown, Pa. In August, 1902, he entered the employ of the Westinghouse Air Brake Company, being assigned duties in the mechanical and engineering departments of its Wilmerding factory. He was connected later with the Cleveland office, then with the Columbus office as mechanical expert in connection with electric railway brakes. In 1914 he was assigned to the Pittsburgh office as assistant resident engineer. where he leaves to take up his new duties.

Joseph H. Woods of the commercial engineering department at Wilmerding has been promoted to engineer of the newly arranged export department. He was born in February, 1886, at Hamilton, Ont. After graduating from the public schools and Hamilton Collegiate, he was employed as an apprentice in a machine shop for three years, and then entered the mechanical drawing room of the Canadian Westinghouse Company, Ltd. In 1908 he was transferred to the air brake department. The following year he entered the engineering test department, and in 1911 was appointed assistant engineer of tests. In 1915 he was transferred temporarily to New Jersey as general foreman of the Air Brake Company's shrapnel loading plant. On completion of the shell loading work in 1916 he returned to Wilmerding to take up duties in the general office division of the engineering department.

Joseph C. McCune, special engineer at Wilmerding, is now assistant to the eastern district engineer, with office in New York. He was born in Brilliant, Ohio, in 1890. He attended the high school at Steubenville, Ohio, and in 1906 entered Washington and Jefferson College, taking preparatory work for one year. He graduated from Cornell University with the class of 1911, receiving the degree of mechanical engineer. He entered the employ of the Cutler-Hammer Manufacturing Company, Milwaukee, Wis., and later served in the traffic department of the Pittsburgh Railway Company. In 1913 he joined the Westinghouse Air Brake Company as assistant to the chief engineer, Dr. Walter V. Turner. In 1915 he was transferred to the New York office as mechanical expert, charged with the development and satisfactory operation of the new air brake equipment then being applied to the subways of Greater New York. In 1916 he served for five months at the Mexican border with the 7th Regiment, N. Y. N. G. Returning from this service, he was commissioned first lieutenant in the Engineer Officers' Reserve Corps, and upon the outbreak of the war with Germany was ordered to active duty. He was an engineering instructor at the 1st, 2d and 3d Officers' Training Camps, and in May, 1918, was assigned to the 603d Engineers, going overseas with this organization and remaining abroad for ten months. Returning to this country, he re-entered the employ of the Westinghouse Air Brake Company as special engineer at Wilmerding.

The Western Electric Company, Inc., 195 Broadway, New York, has reorganized its railroad representative staff under the direction of George H. Porter, manager of the railroad department, as follows: The Western district representatives are: J. P. Casey, St. Louis, Mo.; W. J. Schott, Kansas City, Mo.; George Chestnut, Houston, Tex.; G. N. Hoffman, Salt Lake City, Utah; W. H. Laufenberg, Denver, Colo.; J. E. Coad, Dallas, Tex. Those for the Coast district are: I. A. Shorono, Seattle, Wash.; J. G. Loomer, Los Angeles, Cal.; H. A. Case, San Francisco, Cal.; Jack F. Ryan, Portland, Ore.; J. H. Kelley, Tacoma, Wash.; C. A. Martin, Spokane, Wash. Central district: Otto Danielson, Chicago; E. B. Elliott, Chicago; A. J. McCall, Omaha, Neb.; Tom Wheatley, Cleveland, Ohio; R. D. Eves, Cincinnati, Ohio; W. H. McGann, Cincinnati, Ohio; R. W. Tenbroeck, Toledo, Ohio; C. E. Roberts, Indianapolis, Ind.; W. H. Tompkins, Milwaukee, Wis.; E. B. Denison, Minneapolis, Minn.; G. E. Brown, Duluth, Minn.; A. W. Hillis, Detroit, Mich.; A. Schwenck, Grand Rapids, Mich. Eastern district: Oscar Lepper, Pittsburgh, Pa.; A. B. Thomson, New York; Charles R. Wharton, Philadelphia, Pa.; Fred Jaeger, Philadelphia, Pa.; James Stuard, Philadelphia, Pa.; E. R. Morgan, Boston, Mass. Southern district: William Lancaster, Richmond, Va.; H. B. Stanton, Savannah, Ga.; W. R. Phillips, Jacksonville, Fla.; J. W. Smith, Atlanta, Ga. A. L. Frankenberger remains at St. Paul, Minn., and Sidney Greenfeld at Baltimore, Md.

Arthur Elliot Allen has been appointed district manager at New York for the Westinghouse Electric & Manufacturing Company, to succeed Edward D. Kilburn, who has been elected vice-president and general manager of the Westinghouse Electric International Company. Mr. Allen is a native of Toronto, Canada, and received his education in England and also in this country. In June, 1902, he entered the employ of the Westinghouse Electric & Manufacturing Company at its Newark works, subsequently being placed in charge of the test department, where he remained until 1910. In that year Mr. Allen was loaned by the management of the company to the International Electric Protection Company, for which company he acted as chief engineer. After completing that temporary work, he returned to the employ of the Westinghouse company, and on December 1, 1915, Mr. Allen was appointed manager of the supply division of the New York office, which position he retained until he joined the Canadian Overseas Forces in October, 1917. After being honorably discharged from the army he returned to the New York office of the Westinghouse company as executive assistant to the manager, from which position he was promoted to manager.

A. E. Allen

TRADE PUBLICATIONS

ASBESTOS.—In the December issue of the *Railway Mechanical Engineer* there appeared a short review of the first number of Asbestos, a monthly magazine, in which it was stated that the publisher is the Magnesia Association of America. This statement is erroneous, as the booklet is published by Secretarial Service, 721 Bulletin building, Philadelphia, Pa.

ELECTRIC CRANES.—A bulletin entitled Lane Electric Cranes, has been issued by N. B. Payne & Co., 25 Church street, New York, agents for cranes manufactured by the Lane Manufacturing Company, Montpelier, Vt. The bulletin fully illustrates and describes several styles of cranes in which steel girders or heavy timbers of yellow pine are used, and contains a complete set of specifications.

FURNACE BURNERS. — Bulletin No. 119 of the Hauck Manufacturing Company, Brooklyn, N. Y., describes in detail the many different types of oil burners manufactured by this company and illustrates practical applications of the burners to various types of furnaces. In addition, a number of sketches are included, suggesting other ways of applying Hauck burners, and throughout the book are given results of tests, prices and service data.

AUXILIARY DEVICES GOVERNOR.—Instructions for the installation and care of the auxiliary devices governor have been published for distribution by the Westinghouse Air Brake Company, in a 12-page booklet bound with stiff covers and designated as General Instructions No. 2360. The construction and operation of the governor is described and is supplemented by sketches with the parts numbered and named. Instructions are also given for properly adjusting the pressure.

BOILER FEED CONTROL.—A 24-page booklet entitled Saving Fuel Automatically and Scientifically in the Boiler Room has been published by the Northern Equipment Company, Erie, Pa. It is based upon matter that was prepared for the United States Fuel Administration during the war and compares hand and mechanical feeding with mechanical regulation, as performed by the Copes regulator, being illustrated with a number of charts and diagrams to emphasize the value of scientific control.

BRAKE ROD JAW. — The Schaefer Equipment Company, Pittsburgh, Pa., describes and illustrates, in a four-page pamphlet, the Schaefer drop-forged brake rod jaw for attachment to brake rods. The method of applying the jaw is simple and is illustrated. It is claimed that the jaw may be removed and reattached without any danger from failure and that it may be applied and reapplied without loss. The pamphlet also shows the results of pulling tests on six different jaws fastened on 7/8-in. brake rods, which were made at the Pittsburgh Testing Laboratory.

VALVES.—Catalogue and price list No. 10 of Nelson valves has been issued by the manufacturers, the Nelson Valve Company, Philadelphia, Pa. The book contains 156 pages, 5 in. by 7½ in., and is bound in cloth. It is divided into three parts, devoted respectively to bronze, iron and steel valves, with an introduction describing the general features of the design and service rendered. The valves are made in gate, globe check and non-return patterns for practically every class of service found in power plant work, etc. The book contains numerous illustrations and the data is conveniently arranged.

DRAFT GEARS—Force and Its Applied Principles, is the title of a 28-page booklet, bound in stiff paper covers, which has just been issued by the Union Draft Gear Company, Chicago. The booklet explains concisely and non-technically the elementary relationship of force and motion, defining the terms used. How these principles apply to the operation of the draft gear is then set forth and the booklet concludes with a discussion of draft gear capacity and the essentials of draft gear testing. A table for the conversion of miles per hour into height of fall in feet, for use in calculating the energy in moving cars for speeds from 1 to 10 miles per hour by half mile intervals, is included.

INDUSTRIAL MANAGEMENT.—L. V. Estes, Incorporated, industrial engineers, Chicago, have published a small booklet entitled Human Relations in Industry, for the purpose of pointing out the underlying principles of personal relations and industrial management that are essential to industrial harmony and maximum production. It contains a statement showing the trend of present conditions and the need for definite action by employers, and outlines in a general way the procedure necessary for putting in effect plans tending toward a betterment of human relations in industry.

STEEL PIPE. — National Bulletin No. 24A has been issued by the National Tube Company, Pittsburgh, Pa., and shows graphically the remarkable growth of the steel pipe industry from 1888 to the present time. The chart indicates a decrease in the production of wrought iron pipe during this period. Quotations are given from the editorial columns of three current periodicals in the iron field to show the reasons for the popularity of steel pipe and its probable permanence. Included in the bulletin is a chart showing the relative production of wrought iron and steel skelp from 1888 to 1918.

DROP FORGINGS.—J. H. Williams & Co., Brooklyn, N. Y., manufacturers of Superior drop forgings and drop-forged tools, have issued the seventeenth edition of their catalogue, containing 160 pages, 4 in. by 6 in., fully illustrating and describing their standard stock specialties. These include new lines of "Agrippa" set screw pattern turning tool holders, "Agrippa" boring tool posts, "Vulcan" forged-cutter tool holders, and several new sets of drop-forged wrenches. The book also contains a description of the drop-forging process in simple, non-technical style for the benefit of those not conversant with its details.

OPPORTUNITIES FOR TECHNICAL GRADUATES.—Opportunities for technical garduates are very thoroughly explained in an illustrated pamphlet bearing that title, recently issued by the Westinghouse Electric & Manufacturing Company. This booklet describes, in considerable detail, the plan which has been developed by this company for the training of the graduates of technical schools at all of its various works. In the booklet is included a list of prominent Westinghouse men who originally entered the company as graduate students, as well as a complete list of schools from which over 5,000 students have entered the employ of the company.

INSULATION PRODUCTS.—The Franklin Manufacturing Company, Franklin, Pa., has issued a 77-page catalogue entitled Heat Insulations. This catalogue contains brief descriptions of the company's insulation products, including 85 per cent magnesia pipe covering, railroad special pipe covering, Franklin carlining, asbestos millboard, wool felt covering, etc. Packing and shipping directions are included. The back part of the catalogue contains considerable engineering information in the form of tables and data to be used in the solution of heat insulation problems. Instructions for the use of these tables are given and several concrete examples are worked out.